# FARM LIGHT AND POWER

## YEAR BOOK

1922

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# Farm Light and Power

## YEAR BOOK

# Dealers' Catalog and Service

A Complete Directory of Manufacturers and Wholesalers and a Manual on the Operation and Maintenance of Electric Generators and Motors, Gas and Oil Engines, Storage Batteries, Wiring for Light and Power, Accessories, Appliances, Etc.

1922
Price
$2.50

Farm Light and Power Publishing Co., Inc.

318-326 West 39th Street

NEW YORK

# *Acknowledgment*

Many of the leading manufacturers in the field co-operated in supplying material and illustrations for the Farm Light and Power Year Book and special acknowledgment of courtesies rendered is due to the following:

Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Text and Illustrations—"Light and Power for Villages and Communities."

American Technical Society, Chicago, Ill.
Extracts and Illustrations—Elementary Electrical Principles; Electricity and Magnetism; Principles of Electric Motor Operation; Ignition Principles, and Systems; Principles of Gas Engine Operation, etc., from "Automobile Lighting, Starting and Ignition," by Charles B. Hayward.

Edison Lamp Works of General Electric Co.
Illustrations and Text—"The Right Lamp in the Right Place."

Electric Storage Battery Co., Philadelphia, Pa.
What Specific Gravity Readings Mean; Special Battery Dopes and Powders; Battery Record Sheet, etc.

Fitz Water Wheel Co., Hanover, Pa.
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Westinghouse Lamp Co., New York City.
"Technical Names of Various Parts of Incandescent Lamps."

# *Illustrations*

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Westinghouse Lamp Co., New York City.
White Sewing Machine Co., Cleveland, Ohio.

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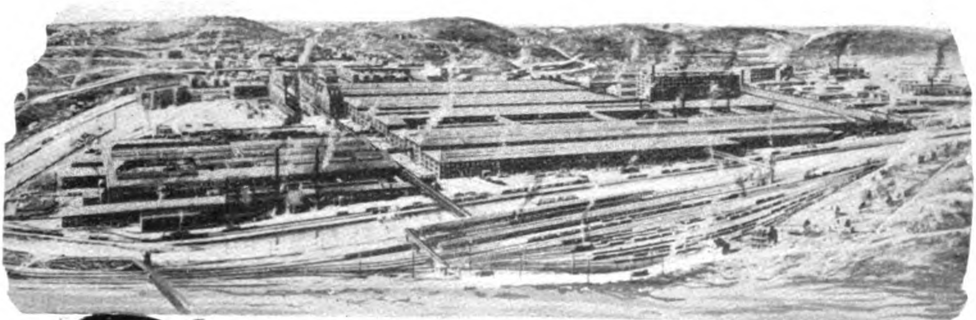

# Buy Your Farm Electrical Apparatus

## From These Electrical Jobbers

WESTINGHOUSE ELECTRIC

Complete information and prices on Westinghouse products can be obtained from these jobbers or district offices.

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Atlanta, Ga., Gilham Schoen Electric Co.
Birmingham, Ala., The Moore-Handley Hardware Co.
Bluefield, West Virginia, Superior Supply Co.
Buffalo, N. Y., McCarthy Bros. & Ford.
Butte, Montana, The Montana Electric Co.
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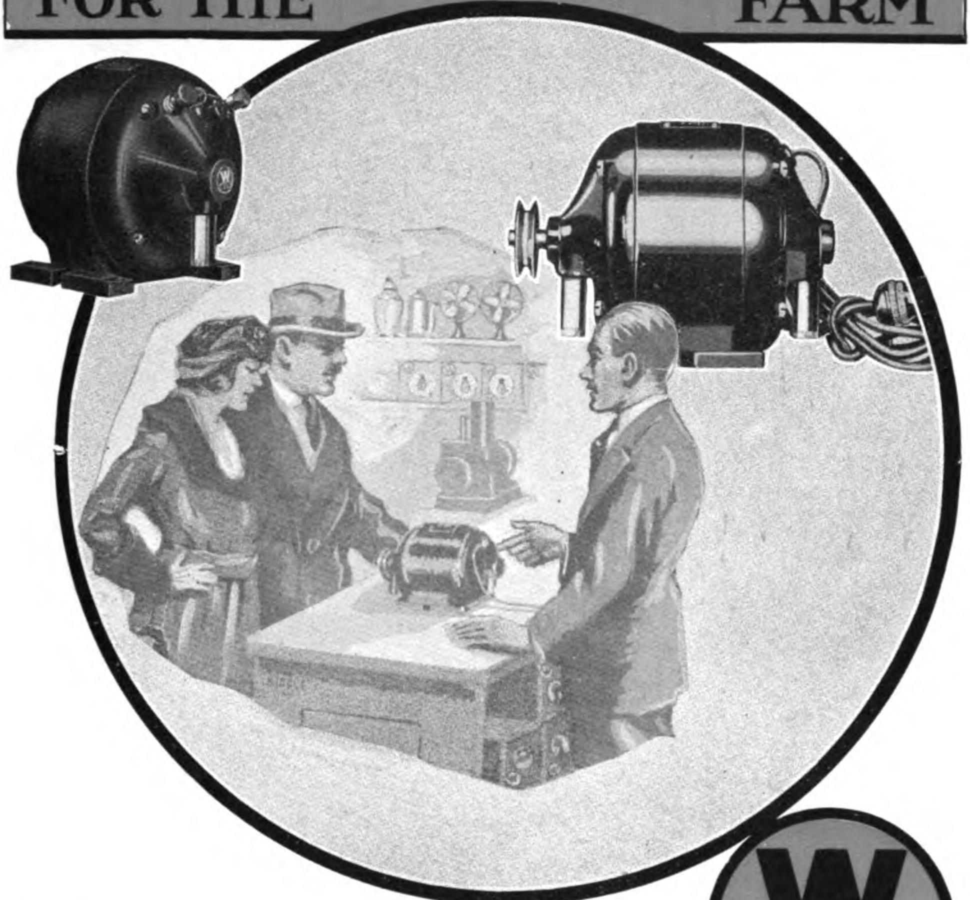
**WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY**
**East Pittsburgh, Pa.**

# Westinghouse

# FOR THE FARM



WESTINGHOUSE ELECTRIC

# Motors—

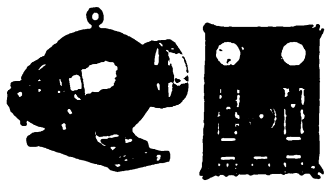
## —in your store

Demonstrate the Westinghouse "Trouble-proof" motors to the farmer. You are offering your customer a reliable, nationally known, product in which he has confidence and which will meet all the requirements of the application.

Complete information and prices on these products can be obtained on request at our nearest office or distributor.

# Westinghouse

# Farm Light and Power Plants



**THE A-C ELECTRICAL MFG. CO.**
**Dayton, Ohio**
**Trade Name, "Dayton" Lighting Outfits**
**(No. of Models 1)**

Generator—Belt drive, 40 volts, 20 amperes.
Switchboard—Voltmeter, ammeter.
Battery—Optional.
Shipping Weight—Without battery, 136 lb., with battery, 1,150 lb.

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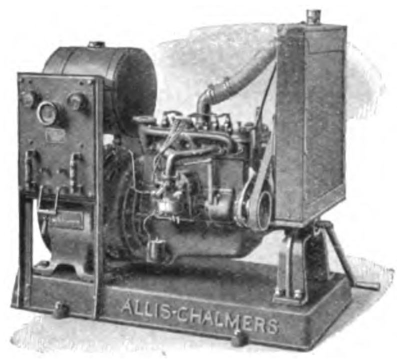
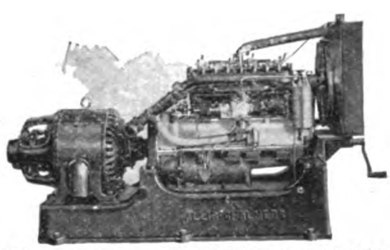



Allis-Chalmers, 5 K W Set, 110 Volts

**ALLIS-CHALMERS MFG. COMPANY,**
**Milwaukee, Wis.**
**Trade Name, "Allis-Chalmers"**
**(No. of Models 2)**

**5 K W Outfit**

Engine—4 cyl., 4 cycle; speed, 1,150 r. p. m.
Cooling—Water, thermo syphon circulation.
Governor—Centrifugal type.
Fuel System—Gravity feed.
Generator—5 K W, 110 or 220 volts.
Switchboard—Voltmeter, ammeter, knife switch, fuses, rheostat mounting.
Battery—Furnished as an extra.
Starting—Hand and electrical.
Floor Space—46" x 24"; height, 45".
Shipping Weight—1,160 lb.



Allis-Chalmers, 15 K W Set, 110 Volts

**15 K W Outfit**

Engine—4 cyl., 4 cycle; speed, 1,150 r. p. m.
Cooling—Water, pump circulation.
Governor—Centrifugal type.
Fuel System—Stewart vacuum system.
Generator—15 K W, 125 volt direct current, 1,150 r. p. m.
Switchboard—Ammeter, voltmeter, ground detector, lamp receptacles, rheostat mounting, D. P. S. T. feeder switches with N. E. C. S. enclosed fuses.
Battery—Furnished as an extra.
Starting—Hand and electrical.
Floor Space—99" x 30"; height, 53".
Shipping Weight—2,900 lb. complete.

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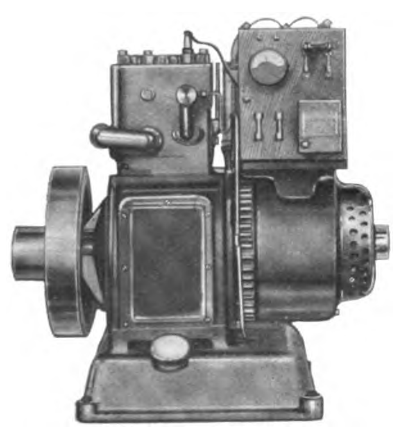
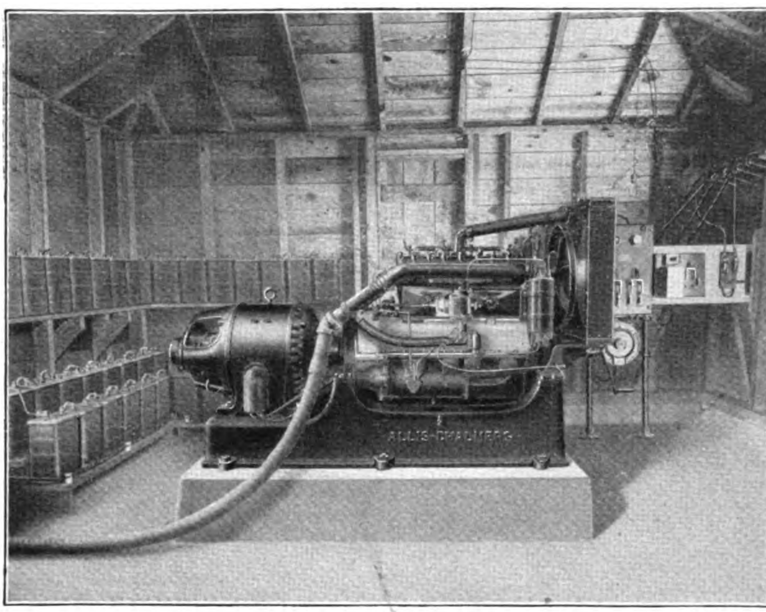


"American Power and Light Plant"

**AMERICAN FARM EQUIPMENT CO.,**
**Williamsport, Pa.**
**Trade Name, "American Power and Light"**
**(No. of Models 1)**

Engine—1 cyl., 3 h. p.; speed, 1,050 r. p. m.
Cooling—Water.
Fuel System—Suction.
Generator—Own make.
Switchboard—Ammeter, starting and stopping switch.
Battery—Any make.
Starting—Semi-automatic.
Stopping—Semi-automatic.
Floor Space—20" x 30".
Shipping Weight—300 lb., less battery.

*A Complete Power Plant furnishing Light and Power to small communities or large farms*



Gasoline Engine Driven Electric Generating Sets complete and ready to operate for small factories, large farms, moving picture theatres, small communities, logging camps, etc. An independent portable light and power plant.

*Made in 5 and 15 KW Capacities—Direct Current*

**Write for Dealers' Proposition**

**ALLIS-CHALMERS MANUFACTURING COMPANY**

**MILWAUKEE, WISCONSIN, U. S. A.**

*District Offices in All Principal Cities*

**THE AUTOMATIC ELECTRIC DEVICES CO., Cincinnati, Ohio**
**Trade Name, "All Purpose Lighting & Power Plant"**

(No Illustration)

Engine—1 cyl., 3 h. p.; speed, 500 r. p. m.
Cooling—Water.
Governor—Centrifugal.
Fuel System—Gasoline.
Generator—Own, 1 K W.
Switchboard—Ammeter, ampere hour meter.
Battery—25 34 Edison—15 gpl lead.
Starting—Automatic.
Stopping—Automatic.
Floor Space—22" x 80".
Shipping Weight—Without battery, 500 lb.; with battery, Edison, 750 lb., Lead, 1,000 lb.

**H. E. BUCKLEN & COMPANY**
**Elkhart, Indiana**
**(No. of Models 1)**

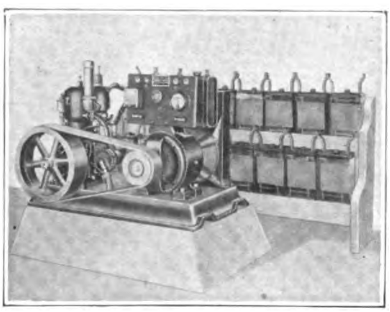
(No Illustration)

Engine—1 cyl., 3 h. p.; speed, 1,300 r. p. m.
Cooling—Water.
Governor—Electric.
Fuel System—Gasoline.
Generator—General Electric, 1,500 watts.
Battery—Globe Mfg. Co.
Starting—Hand.
Stopping—Automatic.

**THE CHAMBERS MFG. CO., Butler, Pa.**
**Trade Name, "Chambers"**
**(No. of Models 1)**

(No Illustration)

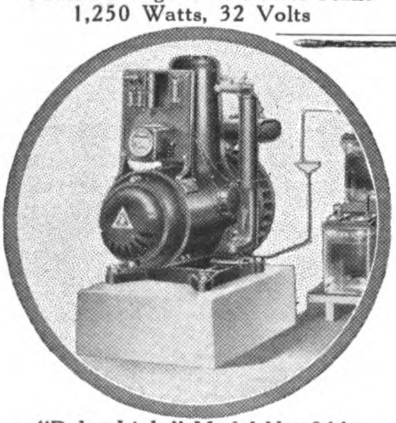
Engine—1 cyl., 4 h. p.; speed, 550 r. p. m.
Cooling—Water.
Governor—Throttle.
Fuel System—Gas, gasoline or kerosene.
Generator—1 K W, 40 volts.
Switchboard—Mounted on generator.
Battery—9 plates, 107 ampere.
Starting—Electric.
Floor Space—60" x 24".
Shipping Weight—1,400 lb.



"Cushman Light and Power Plant"
1,250 Watts, 32 Volts

**CUSHMAN MOTOR WORKS, Lincoln, Neb.**
**Cushman Electric Light and Power Plant**
**(No. of Models 3)**

Engine—1 cyl., 4 h. p.; speed, 800 r. p. m.
Cooling—Water.
Governor—Fly-ball type.
Fuel System—Gasoline.
Generator—1¼ K W; 31 ampere; 32 volt D. C.
Switchboard—Ammeter, rheostat, circuit breaker, fuses, self starter.
Battery—Model "A": 16 cells, 32 volts, 130 A. H.; Model "C": 16 cells, 32 volts, 175 A. H.; Model "E": 16 cells, 32 volts, 260 A. H.
Starting—Self starter, push button.
Floor Space—37" x 26".
Shipping Weight—Including battery, approximately 650 lb.



"Delco-Light" Model No. 866
850 Watts, 32 Volts

**DELCO-LIGHT COMPANY, Dayton, Ohio**
**Trade Name, "Delco-Light"**
**(No. of Models 25)**

Engine—1 cyl., 4 cycle; speed, 1,100 r. p. m.
Cooling—Air.
Governor—Battery control.
Fuel System—Simple mixing valve. Suction feed.
Generator—850 watts.
Switchboard—Ampere-hour meter, combination starting switch and cut-out, battery fuse and fused line switch.
Battery—16 cells, 32 volts, 160 A. H.
Starting—Semi-automatic.
Floor Space—25" x 20".
Shipping Weight—424 lb.

# What Our Selling Franchise Means to You

### The Unlimited Field

Every farmer will have city conveniences—if not today, then tomorrow. The first thing he requires is electric light and power. This makes every farmer a prospect for a home light plant unless he now has electric service.

### The Plant He Will Buy

The one thing the farmer wants is service. He wants a plant he can understand—one that will give him all the light he needs—and power besides. And all this year after year.

### Demanding Your Confidence

The Home Light Plant is the product of thirty years' experience in studying how to meet the farmer's power needs. Every farmer knows the "Z" Engine—the power behind the Home Light Plant. The same talent, the same factory, the same integrity, guarantee the same Fairbanks-Morse Quality.

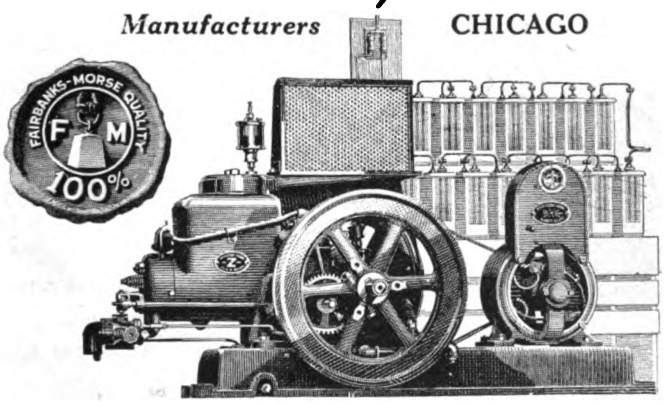
### Co-operation

As a Home Light Plant Dealer, your cause is our cause. There is a Fairbanks-Morse Branch House near you—you at once become an active part of that big sales organization. Consistent farm paper advertising directs prospects to you.

*"Only 500 a minute"*

## FAIRBANKS, MORSE & CO.

*Manufacturers* CHICAGO




**Consumer Prices**

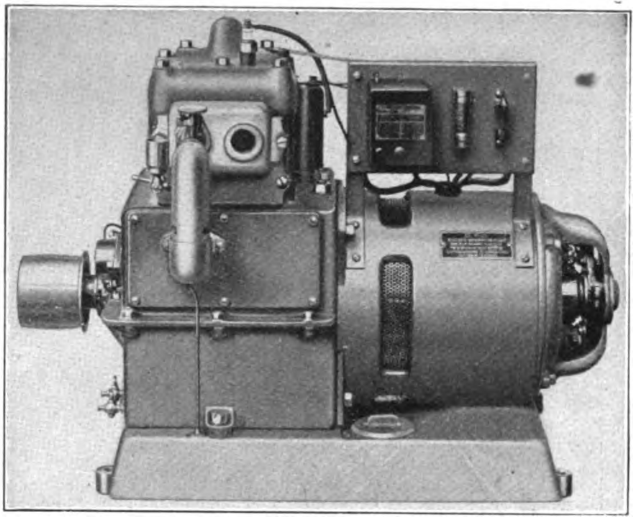
**\$295**

**and**

**\$525**

**F. O. B. factory.**

**Add freight to your town.**



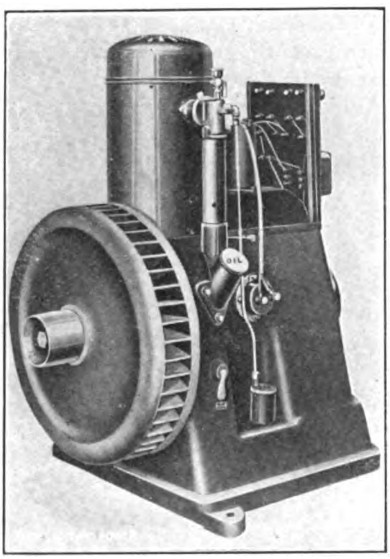
Columbian "C-Y-C" Plant

**COLUMBIAN BRONZE CORPORATION**

**New York, N. Y.**

**Trade Name, "Columbian "C-Y-C"**

Engine—1 cyl., 4 h. p.; speed, 1,200 r. p. m.
Cooling—Water, thermo syphon circulation.
Governor—Load governed.
Fuel System—Suction lift.
Generator—Stamford Elec. Co., 1½ K W.
Switchboard—Starting box, fuse, field switch, ammeter.
Battery—Prest-O-Lite.
Starting—Semi automatic.
Stopping—Automatic.
Floor Space—33" x 22".
Shipping Weight—Without battery, 525 lb., with battery, 1,-100 lb.



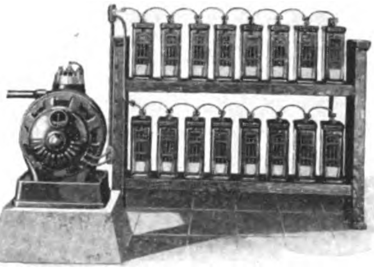
"D-Light" Plant, 1,500 Watts 32 Volts

**H. C. DODGE, INC., Boston, Mass.**

**Trade Name, "D-Light"**

(No. of Models 3)

Engine—1 cyl., 4 cycle; speed, 1,200 r. p. m.
Cooling—Air circulation.
Governor—Centrifugal.
Generator—4 pole, 1,500 watts, 36 volts.
Switchboard—Ammeter, automatic switch and rating plate, load and line fuses, two double pole knife switches.
Battery—Type L-1,500-1—16 cells, 32 volts, 100 ampere hours at 8 hours continuous discharge rate.
Type L-1,400-4—16 cells, 32 volts, 120 ampere hours at 8 hour continuous discharge rate.
Type L-1,500-7—16 cells, 32 volts, 160 ampere hours at 8 hour continuous discharge rate.
Starting—Push button.
Floor Space—23" x 32"; height, 38".
Shipping Weight—600 lb., less battery.



"Willys-Light Junior"
600 Watts, 32 Volts

**ELECTRIC AUTO-LITE CORPORATION**

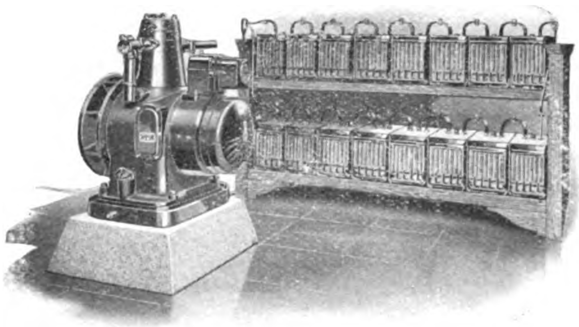
**Toledo, Ohio**

**Trade Name, "Willys-Light Junior and Willys Light"**

(No. of Models 5)

**Willys Light Junior**

No. of Models: Three—600 watt Engine Generator with 80 A. H. Battery—600 watt Engine Generator with 160 A. H. battery—600 watt Engine generator with 240 A. H. battery.
Engine—1 cyl., 1¼ h. p.; speed, 1,700 r. p. m.
Cooling—Air cooled.
Fuel System—Suction to simple mixing valve.
Generator—Own make; 600 watts.
Battery—Exide or U. S. L. 80-160-240 A. H.
Starting—Hand.
Stopping—Automatic.
Floor Space—23" x 15"; height, 24".
Shipping Weight—Without battery, 250 lb., with battery, 775 lb.



"Willys-Light 1,250 Watts, 32 Volts

## ELECTRIC AUTO-LITE CORP'N
**Toledo, Ohio**

**Trade Name, "Willys-Light Junior and Willys Light"**

### Willys Light

No. of Models: Two—1,250 watt Engine Generator with 160 A. H. battery—1,250 watt Engine Generator with 240 A. H. battery.

Engine—1 cyl., 2½ h. p.; speed 1,350 r. p. m.
Cooling—Air cooled.
Fuel System—Suction to simple mixing valve.
Generator—Own make, 1,250 watts.
Battery—Exide or U. S. L.; 160-240 A. H.
Starting—Hand.
Stopping—Automatic
Floor Space—28" x 24"; height, 30".
Shipping Weight—Without battery, 500 lb.; with battery, 1,125 lb.

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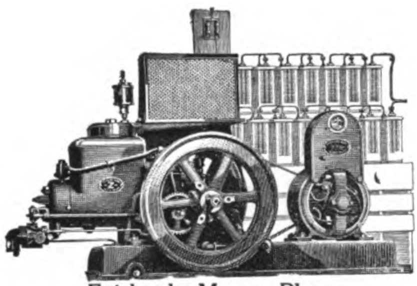

Fairbanks-Morse Plant
600 Watts, 32 Volts

## FAIRBANKS, MORSE & CO., Chicago, Ill.
**Trade Name, "Home Light"**

**(No. of Models 2)**

### Model "One and a Half Home Light"

Engine—1 cyl., 1½ h. p.; speed, 500 r. p. m.
Generator—600 watts; voltage, 30-42; speed, 2,000 r. p. m.
Battery—"Gould," capacity, 60 A. H., or 1,800 watt hours (8 hour basis).
Floor Space—51⅛" x 21¾"; battery 48" x 20".
Height—Plant 28"; battery 40".
Shipping Weight—Complete, 933 lb.

(No Illustration)

### Model "Three"

Engine—1 cyl., 3 h. p.; speed, 475 r. p. m.
Cooling—Water.
Generator—1,500 watts; voltage, 30-42; speed, 2,000 r. p. m.
Battery—"Gould"; capacity, 160 A. H., or 4,800 watt hours (8 hour basis).
Floor Space—60⅝" x 29⅜"; battery, 56⅛" x 23½".
Height—Plant, 33"; battery, 55".
Shipping Weight—Complete, 1,685 lb.

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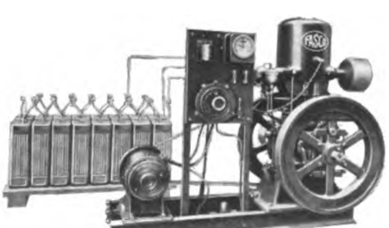
## FASCO ELECTRIC LIGHT PLANT CO.
**Latrobe, Pa.**

**Trade Name, "Fasco"**

**(No. of Models 1)**




"Fasco" 1 K W Light and Power Plant

Engine—1 cyl., 2 h. p.; speed, 600 r. p. m.
Cooling—Water, thermo syphon circulation.
Governor—Throttling governed.
Fuel—Gasoline or kerosene, pump feed.
Power Pulley—6" diameter, 5" face.
Generator—1,000 watt capacity.
Switchboard—Sangamo electric meter, combination entrance switch and fuses, automatic cut-out and starting switch, and rheostat.
Starting—Electrically by starting button on switchboard.
Battery—Willard, glass 16 cell, 32 volt; capacity, 80 to 240 A. H. sizes.
Floor Space—14" x 42".
Shipping Weight—600 lb., less battery.

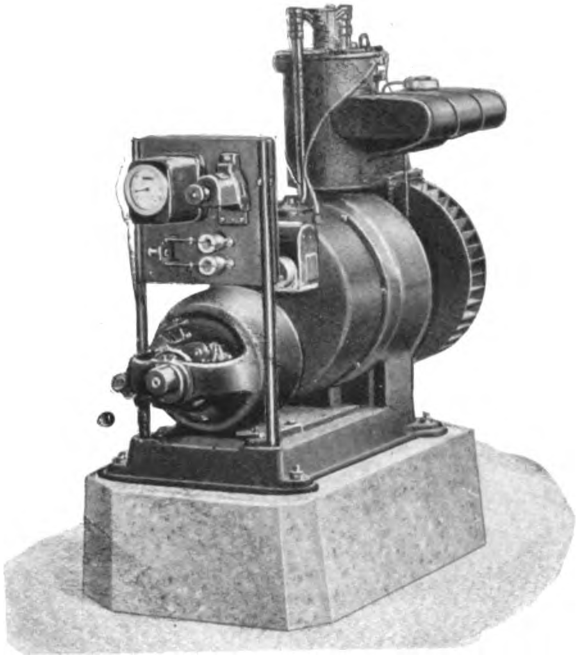
(No Illustration)

**ELECTRIC COMPANY—WIND**
**Minneapolis, Minn.**

**Wind Driven Plant**

**Trade Name, "Aerolite"**

Power Unit—14-ft. steel wind turbine on tower.
Drive—Belt on wheel and idler to generator on tower.
Generator—1,500 watt, special type.
Battery—16 cells, Philadelphia, 198 A. H.

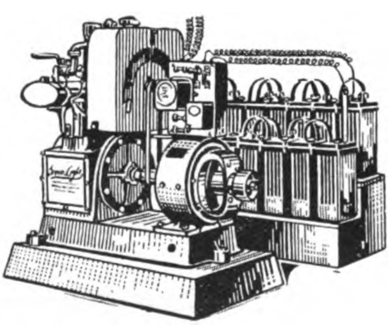


"Fort Dearborn" Plant— 1,000 Watts, 32 Volts

**FORT DEARBORN MFG. CO., Sterling, Ill.**

**Trade Name, "Fort Dearborn"**

Engine—1 cyl., 2 h. p.; speed, 1,000 r. p. m.
Cooling—Air circulation.
Fuel System—Suction direct, from tank.
Generator—32 volts, 1,000 watts D. C., shunt wound, 2,000 r. p. m.
Switchboard—Ampere hour meter, cut-out, starting switch, line switch, fuse plugs and magneto switch.
Battery—16 cells, furnished in the following capacities: 60 to 215 A. H.
Starting—Switch; stopping, automatic.
Floor Space—16" x 37"; height, 32".
Shipping Weight—500 lb., without battery.



"Genco" Plant
Models "A" and "B," 32 Volts

**GENERAL GAS-ELECTRIC CO.,**
**Hanover, Pa.**

**Trade Name, "Genco Light"**

**(No. of Models 4)**

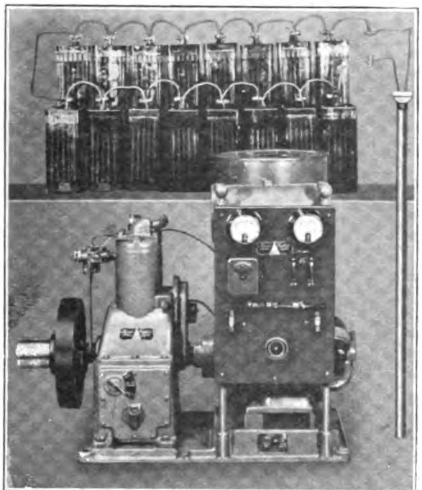
**Models "A" and "B," 32 Volts**

Engine—1 cyl., 4 cycle.
Cooling—Water, thermo syphon circulation.
Generator—2 pole, 32 volts.
Switchboard—Ampere hour meter, ignition fuse, ignition switch, bipole switch, automatic cut-out.
Battery—16 cells, 32 volts.
Starting—Push button.
Stopping—Automatic when batteries are fully charged.
Floor Space—32" x 17".
Shipping Weight—Including battery, 1,125 lb.

**Models "C" and "D," 110 Volts**

(No Illustration)

Engine—2 cyl., 4 cycle; speed, 1,200 r. p. m.
Cooling—Water, thermo syphon circulation.
Fuel System—Vacuum feed.
Generator—2½ K W, 110 volts.
Switchboard—Starting switch, bipole switch, ampere hour meter, cut-out, fuses.
Battery—Type "C"—54 cells, 110 volts, capacity, 110 A. H. Type "D"—54 cells, 110 volts, capacity, 167 A. H.
Starting—Hand and automatic push button.
Floor Space—20" x 54"; height, 43".
Shipping Weight—Including battery, type "C" 3,250 lb.; type "D" 3,600 lb.



Type "D" Hauss Plant
1,000 Watts, 32, 64 or 110 Volts

## ALBERT F. HAUSS COMPANY
### Cincinnati, Ohio
### Trade Name, "Hauss-System"

### Type D

Engine—1 cylinder, 3 h. p.; speed, 1,100 r. p. m.

Cooling System—Water, thermo syphon.

Governor—Throttling.

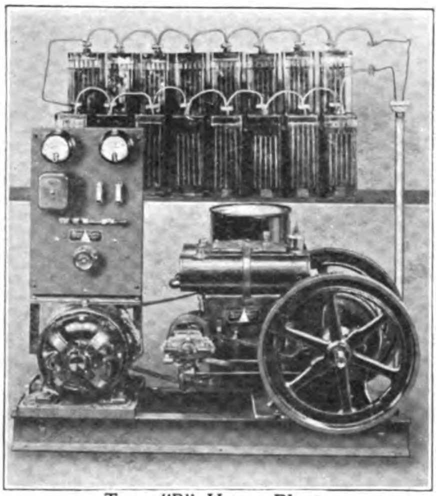
Fuel System—Gravity feed.

Starting—Hand.

Generator—Standard make, 32, 64 or 110 volts, 25 amperes, 1,000 watts.

Switchboard—Starting and lighting switches, voltmeter, ammeter, rheostat, circuit breaker.

Battery—16-35-60 cells, Faure type in sealed glass jars, 90 to 210 A H, 8 hours continuous duty rating.



Type "B" Hauss Plant
800 Watts and Larger; 32, 64 or 110 Volts

### Type B

Engine—1 cylinder, 2 h. p.

Cooling System—Water, thermo syphon circulation.

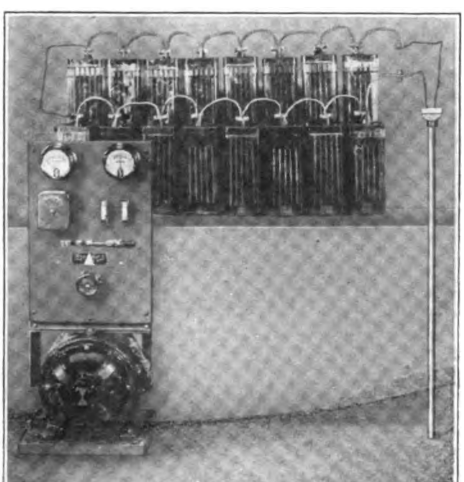
Governor—Throttling.

Starting—Hand.

Generator—Standard make, 40-80 or 140 volts, capacities 800 watts and larger.

Switchboard—Voltmeter, ammeter, cranking and charging switch, automatic cut-out, voltage and charge regulator.

Battery—Faure type, 16-35-60 cells in sealed glass jars, capacities from 60 to 210 A. H., 8 hours continuous duty rating.



Type "G" Hauss Plant
500, 750 and 1,000 Watts; 32, 64 or 110 Volts

### Type G

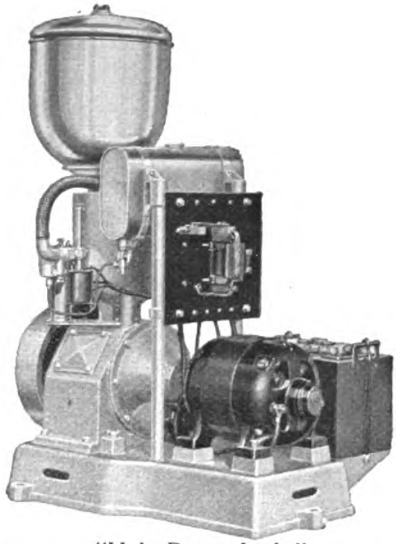
To be belted to any farm engine or milking machine outfit, making same self-cranking.

Capacities—½, ¾ and 1 K W.

Generator—Standard make, ring oiler or ball bearing.

Switchboard—Voltmeter, ammeter, automatic cut-out, fuses, voltage and current regulator and cranking and charging switch.

Batteries—Faure type, 16-35-60 cells in sealed glass jars, 60 to 210 A. H. capacities, 8 hours continuous duty rating.



"Holt Power-Light"
Two Models 3/4 K W & 1 1/4 K W

## HOLT POWER LIGHT CO., Detroit, Mich.

**Trade Name, "Holt Power-Light"**

**(No. of Models 2)**

Engine—1 cyl., ¾ K W model, 1.7 h. p.; 1¼ K W model, 2.8 h. p.

Cooling System—Water percolator.

Fuel System—Gasoline. Gravity feed.

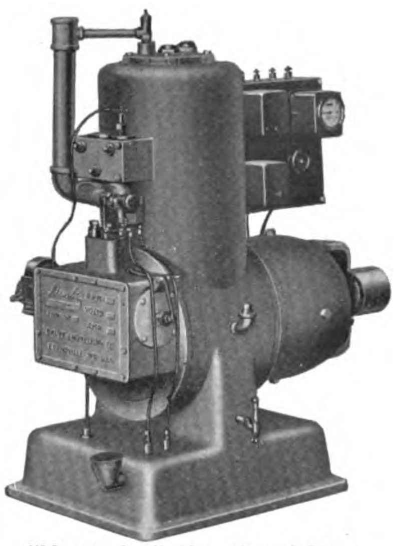
Generator—General Electric, ¾ and 1¼ K W.

Starting—Automatic.

Battery—6 volt for ¾ K W model; 12 volt for 1¼ K W model. Automobile type for starting only.

Floor Space—20" x 30½".

Shipping Weight—Without battery, 550 lb.; with battery, 610 lb.



"Hoosierlite" Slow Speed Plant
1,500 Watts, 32 Volts

## HOOSIER FARM LIGHT COMPANY

**Evansville, Indiana**

**Trade Name, "Hoosierlite Slow Speed"**

**(No. of Models 1)**

Engine—1 cylinder, 3½ h. p.; speed, 700 r. p. m.

Cooling—Water, thermo syphon circulation.

Governor—Fly-ball.

Fuel System—Gasoline tank in base of plant and forced to carburetor by pump.

Generator—Own make, 1,500 watts, normal capacity.

Switchboard—Sangamo A. H. meter, starting and stopping switch, rheostat control, automatic cut-out controlling up to 40 amperes.

Battery—16 cell, glass jar type, 180 A. H., 8 hour rating, 240 A. H. intermittent rating.

Starting—Semi-automatic.

Stopping—Automatic.

Floor space—44" x 27"; height, 41".

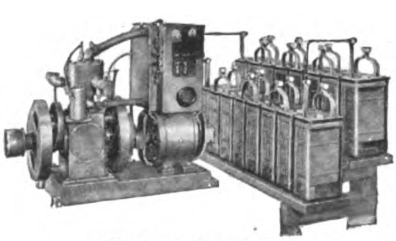
Shipping Weight—Without battery, 850 lb.; with battery, 1,750 lb.

## INDEPENDENT LIGHT AND POWER CO.

**Oelwein, Iowa**

**Trade Name, "Independent"**

**(No. of Models 1)**



"Independent" Plant
1,500 Watts, 32 Volts

Engine—1 cyl., 3½ h. p.; speed, 200 to 750 r. p. m.

Cooling—Water, thermo syphon circulation.

Governor—Centrifugal.

Fuel System—Gravity feed.

Generator—1,500 watts, 32 volts.

Switchboard—Voltmeter, ammeter, automatic cut-out and starting switch, 2 line fuses, also rheostat which permits the charging of from 2 to 37 amperes.

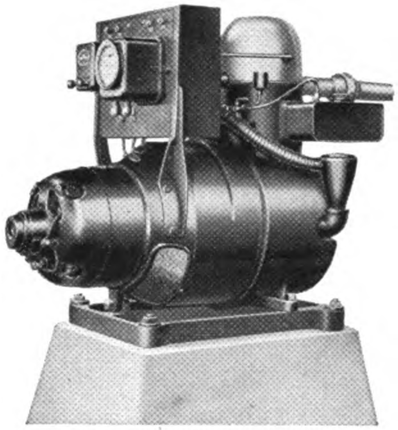
Battery—Philadelphia Diamond Grid, 16 cell, 5 sizes, 32 volts, 95 to 277 A. H.

Starting—Automatic.

Floor Space—14" x 30".

Shipping Weight—500 lb. crated, less battery.

Weight of Batteries—700 to 1,000 lb., depending on size.



Ker-o-el Air-Cooled Plant
750 Watts, 32 Volts

**THE KER-O-EL SALES CO., Cleveland, Ohio**

**Trade Name, "Ker-o-el"**

**(No. of Models 4)**

**Air Cooled Plant—¾ K W**

Engine—1 cyl., 4 cycle; speed, 1,500 r. p. m.
Cooling—Air circulation.
Fuel System—Vacuum feed, thermostatic control.
Generator—750 watts, 32 volts.
Control Board—Fused line switch, ampere hour meter and starting box circuit breaker.
Battery—16 cells, 32 volts, furnished in 2 sizes: 80 and 160 A. H. capacity.
Starting—Push Button.
Floor Space—26" x 26" x 14".
Shipping Weight—360 lb., less battery.

(No Illustration)

**Water Cooled Plant—1 K W**

Engine—1 cyl., 4 cycle; speed, 1,500 r. p. m.
Cooling—Water.
Fuel System—Vacuum feed, thermostatic control.
Generator—1 K W, 40 volts.
Control Board—Fused line switch, ampere hour meter and starting box circuit breaker.
Battery—16 cells, 32 volts. Furnished in 2 sizes: 80 and 160 A. H. capacity.
Starting—Push button.
Floor Space—26" x 26" x 14".
Shipping Weight—360 lb., less battery.

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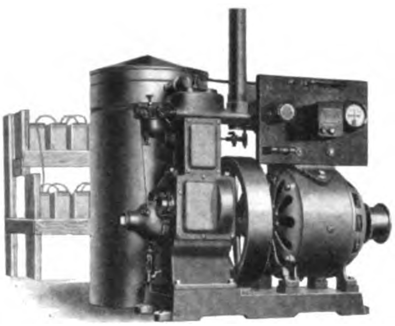

"Kewanee" Plant
1,500 Watts, 32 Volts

**KEWANEE PRIVATE UTILITIES COMPANY**

**Kewanee, Illinois**

**Trade Name, "Kewanee"**

Engine—1 cyl., 3 h. p.; speed 1,100 r. p. m.
Cooling—Water, thermo syphon circulation.
Governor—Centrifugal.
Fuel System—Gravity or vacuum feed.
Generator—Own make, 1,500 watts, 32 volts.
Switchboard—Rheostat, ammeter and circuit breaker.
Battery—16 lead cells, 120 to 305 A. H. capacity.
Starting—Semi-automatic.
Stopping—Semi-automatic.
Floor Space—24" x 12".
Shipping Weight—Without battery, 500 lb., with battery, 1,100 to 1,700 lb.

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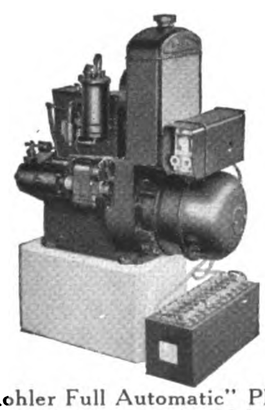
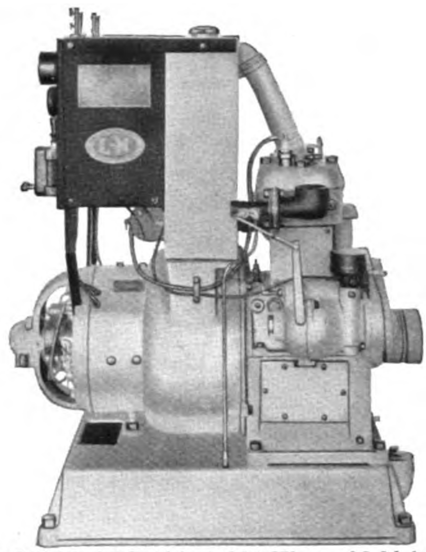


"Kohler Full Automatic" Plant
1,500 Watts, 110 Volts

**KOHLER COMPANY, Kohler, Wis.**

**Trade Name, "Kohler Automatic Power and Light"**

Engine—4 cyl., 3½ h. p.; speed, 1,000 r. p. m.
Cooling—Water, thermo syphon circulation.
Governor—Centrifugal.
Fuel System—Vacuum feed.
Generator—1,500 watts, 110 volts.
Switchboard—Automatic, Kohler patent.
Battery—24-volt automobile type for starting only.
Starting—Fully automatic.
Floor Space—33½" x 14"; height, 34¾".
Shipping Weight—705 lb. complete.



"L-M" Model B 1½, 1,500 Watts, 32 Volts

## LANGSTADT-MEYER COMPANY

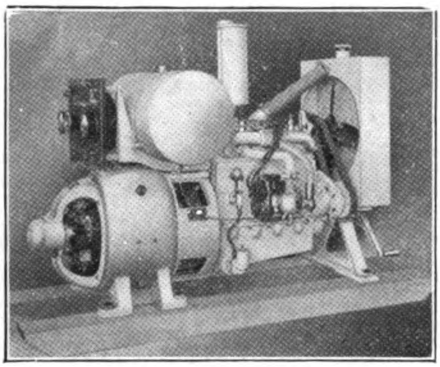
**Appleton, Wisconsin**

**Trade Name "L-M"**

(No. of Models 3)

### Model B-1½

Engine—1 cyl., 4 h. p.; speed, 1,200 r. p. m.
Cooling—Water, thermo syphon circulation.
Governor—Centrifugal.
Fuel System—Suction lift.
Generator—1,500 watts, 32 volts.
Switchboard—Voltmeter, ammeter, rheostat, automatic cut-out, fuses and main switch.
Battery—32 volts, 16 cells Fauré type.
Starting—Push button.
Floor Space—15" x 30"; height, 34".
Shipping Weight—Without battery, 500 lb.; with battery, 1,325 lb.



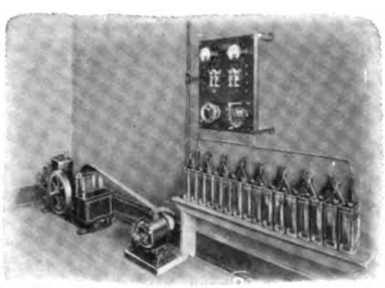
"L-M" Model 2-C-4 4 K W., 110 Volts

### Model 2-C-4 Unit

Engine—4 cyl.; speed, 950 r. p. m.
Cooling—Water, thermo syphon circulation.
Governor—Centrifugal.
Fuel System—Float feed carburetor.
Cenerator—4 K W direct current compound wound 110 volts interpole.
Switchboard—Voltmeter, ammeter, rheostat, double pole fused main switch and ignition switch.
Starting—Hand or battery cranking.
Floor Space—66" x 24"; height, 40".
Shipping Weight—1,050 lb.

### Model 2-C-6 Unit

Engine—4 cyl.; speed, 1,100 r. p. m.
Cooling—Water, thermo syphon circulation.
Governor—Centrifugal.
Fuel System—Float feed carburetor.
Generator—6 K W direct current compound wound 110 volts, interpole.
Switchboard—Voltmeter, ammeter, rheostat, double pole fused main switch and ignition switch.
Starting—Hand or battery cranking.
Floor Space—66" x 24"; height, 40".
Shipping Weight—1,100 lb.



"Wisconsin" Plant
800 Watts to 3 K W, 32 Volts

## THE LAUSON-LAWTON COMPANY

**Depere, Wis.**

**Trade Name, "Wisconsin"**

(No. of Models 4)

Engine—1 cyl., model 2, 2½ h. p.; speed, 400 r. p. m.; model 3, 3 h. p.; speed, 400 r. p. m.; model 4, 4 h. p.; speed, 380 r. p. m.; model 5, 7 h. p.; speed, 350 r. p. m.
Cooling—Water.
Governor—Fly-ball.
Fuel System—Gravity feed.
Generator—Model 2, 15 amperes, 32 volts, 1,800 r. p. m.; model 3, 20 amperes, 32 volts, 1,800 r. p. m.; model 4, 50 amperes, 32 volts, 1,500 r. p. m.; model 5, 75 amperes, 32 volts, 1,500 r. p. m.
Switchboard—Voltmeter, ammeter, rheostat, automatic cut-out, generator and light switches.
Starting—Hand.

"Lincoln Light" Plant 1,000 Watts, 32 Volts

## LINCOLN LIGHT CORP., Grafton, Wis.

### Trade Name, "Lincoln Light"

Engine—1 cyl., 3 h. p.; speed, 1,250 r. p. m.
Cooling—Water and air.
Governor—Throttle.
Fuel System—Suction.
Generator—Own make, 1 K W.
Switchboard—Ammeter.
Battery—190 A. H.
Starting—Semi-automatic.
Stopping—Automatic.
Floor Space—18" x 18".
Shipping Weight—Without battery, 300 lb.; with battery, 1,200 lb.

"Electrion" Plant
1,100 Watts, 32 Volts

## LINDERMAN STEEL & MACHINE CO., Dayton, Ohio

### Trade Name, "Electrion"

(No. of Models 3)

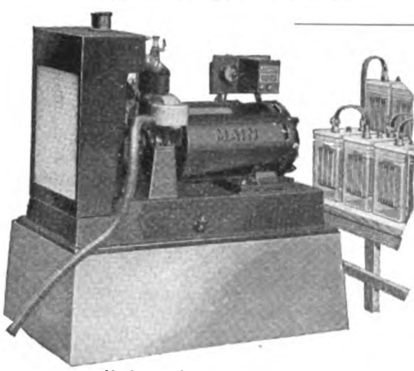
### 32 Volt Semi-Automatic and Full Automatic Types

Engine—1 cyl., 2½ h. p.; speed, 1,600 r. p. m.
Cooling—Thermo syphon system.
Governor—Electric.
Fuel System—Gasoline, Bennett type carburetor.
Generator—Own make, 1,000 watts, 32 volts.
Switchboard—Removable unit.
Battery—Any standard make (purchaser's option).
*Starting—Hand. Stopping—Automatic.
Floor Space—18" x 30".
Shipping Weight—520 lb.

*The 32-volt full automatic "Electrion" is identical with the semi-automatic with the exception that it both starts and stops automatically.

### 110 Volt Automatic Type

Engine—1 cyl., 2½ h. p.; speed, 1,600 r. p. m.
Cooling—Thermo syphon system.
Governor—Electric.
Fuel System—Vacuum feed, metering valve, gasoline.
Generator—General Electric, 1,000 watts, 110 volts.
Switchboard—Removable unit.
Battery—6 volts, automobile type, for starting only.
Floor Space—18" x 30". Shipping Weight—520 lb.



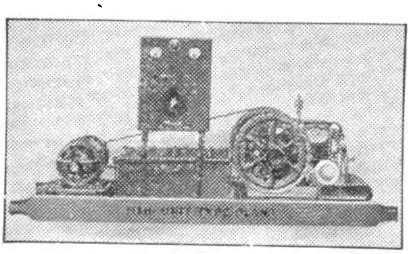
"Main Power Light"
1,000 and 1,500 Watts, 32 Volts

## MAIN ELECTRIC COMPANY, Cleveland, Ohio

### Trade Name, "Main Power Light"

(No. of Models 3)

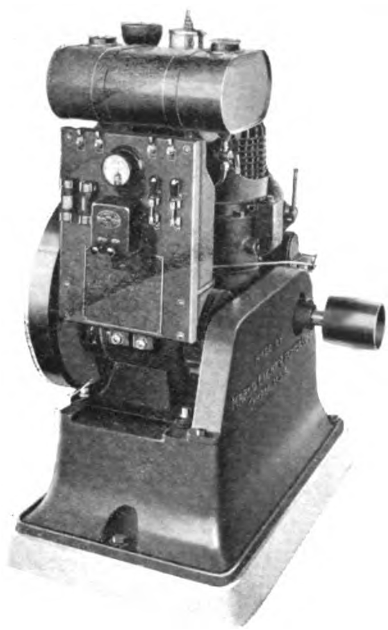
Engine—1 cyl. (1 K W model) 2 h. p.; speed, 1,200 r. p. m.; (1,500 watt model) 2½ h. p.; speed, 1,500 r. p. m.
Cooling—Water, thermo syphon circulation through honey comb radiator employing fan.
Governor—Electric.
Fuel System—Tank in base.
Generator—(1 K W model) 1,000 watts, 32 volts; (1,500 watt model) 1,500 watts, 32 volts, steel frame, ball bearings.
Battery—16 cells, sealed glass jar type (1 K W model) 60, 90 or 160 ampere hour; (1,500 watt model) 90, 160 or 225 ampere hour.
Switchboard—Ammeter, automatic cut-out, with start and stop push buttons.
Starting—Push button, electrically cranked.
Floor Space—12" x 34"; height, 24".
Shipping Weight—(1 K W model) 675 lb. with 60 A. H. battery; (1,500 watt model) 850 lb. with 90 A. H. battery.



"M C F" Belted Type
800 Watts, 32 Volts

### M C F Belted Type Outfit

Engine—1½ h. p.
Cooling—Water.
Governor—Throttling.
Fuel System—Tank in base.
Generator—800 watts.
Switchboard—Voltmeter, ammeter, cut-out, rheostat, switches and fuses.
Battery—16 cells, sealed glass jars, 40, 60, 90 and 160 A. H. sizes.
Starting—Electrically cranked.
Floor Space—24" x 72".
Shipping Weight—810 lb.



"Marco" Plant
1,500 Watts, 32 Volts

## MARCO POWER AND LIGHT CORP.

**Chicago, Ill.**

**Trade Name, "Marco"**

Engine—4 cyl., 5 h. p.; speed, 800 r. p. m.
Cooling—Air.
Governor—Throttle.
Fuel System—Gravity.
Generator—Dyneto, 1,500 watts.
Switchboard—Ammeter, cut-out, fuses, switches.
Battery—Own make, 112, 150, 225 ampere hour.
Starting—Hand.
Stopping—Hand.

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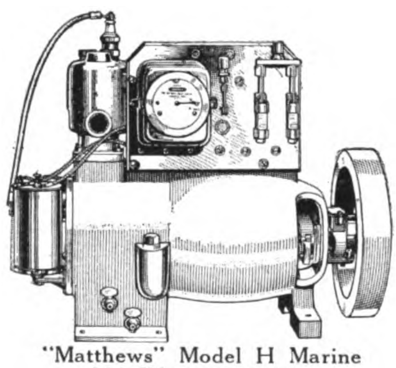


"Matthews" Model H Marine
300 Watts, 32 Volts

## THE MATTHEWS ENGINEERING CO.

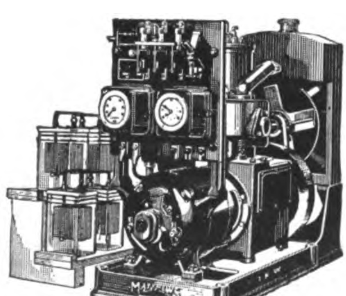
**Sandusky, Ohio**

**Trade Name, "Matthews"**

**(No. of Models 8)**

### Model H

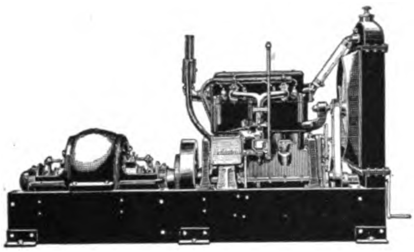
Engine—1 cyl.; speed, 900 r. p. m.
Cooling—Water, thermo syphon system.
Governor—Electric.
Fuel System—Stewart.
Generator—300 watts, 32 volts.
Switchboard—Ampere hour meter, cut-out, switches, fuses and hand starting or test button.
Battery—Willard, 16 cells, 80 A. H. capacity.
Starting—Automatic.
Floor Space—14" x 22".
Shipping Weight—165 lb., less battery.



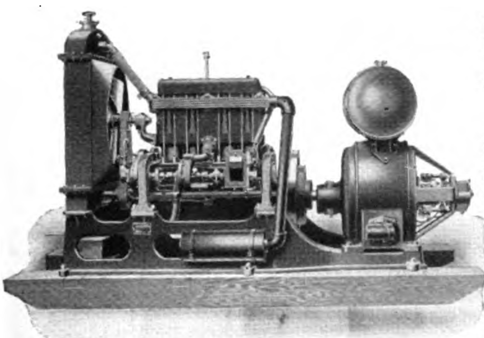
"Matthews" Model Jr. Full Automatic
1,000 Watts, 32 Volts

### Model Jr.

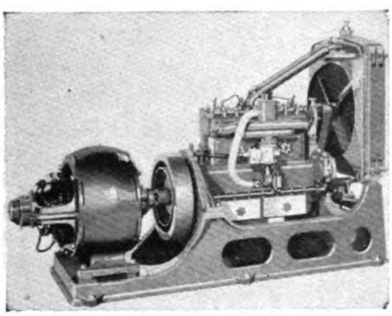
Engine—1 cyl.; speed 1,000 r. p. m.
Cooling—Water, thermo syphon system.
Governor—Electric.
Fuel System—Stewart.
Generator—General Electric, 1,000 watts, 32 volts.
Switchboard—Ampere hour meter, cut-out, circuit breaker, switches, fuses, terminals and hand starting or test button.
Battery—Willard, 16 cells, 80 A. H. capacity.
Starting—Full automatic.
Floor Space—32" x 23".
Shipping Weight—400 lb., less battery.



"Matthews" 4 and 6 K W Plants,
Full Automatic
4 and 6 K W, 110 Volts



"Matthews" 10 and 20 K W Plants
10 and 20 K W, 110 and 220 Volts



"Matthews" 30 and 40 K W Plants
30 and 40 K W, 110 and 220 Volts

## THE MATTHEWS ENGINEERING CO.

**Sandusky, Ohio**

**Trade Name, "Matthews"**

### Models 4 K W and 6 K W—110 Volts

Engine—4 cyl.; speed 900 r. p. m.

Cooling—Radiator.

Governor—Electric.

Fuel System—Stewart

Generator—General Electric, 110 volts, 4 K W model, 4,000 watts capacity; 6 K W model, 6,000 watts capacity.

Switchboard—Control meters, circuit breaker, cut-out, switches, fuses, rheostat for controlling the battery current used in starting.

Battery—Willard, 56 cells, 120 A. H. capacity.

Starting—Full automatic.

Floor Space—4 K W model, 42" x 80"; 6 K W model, 44" x 88".

Shipping Weight—1,700 lb., less battery.

### Models 10 K W and 20 K W—110-220 Volts

Engine—4 cyl.; speed, 900 r. p. m.

Cooling—Radiator.

Governor—Mechanical.

Fuel System—Stewart or gravity.

Generator—General Electric, 110-120 volts, 10 K W model, 10,000 watts capacity; 20 K W model, 20,000 watts capacity.

Switchboard—Voltmeter, ammeter, switches.

Battery—Portable type and used with or without battery.

Starting—Push button.

Floor Space—10 K W model, 42" x 66"; 30 K W model, 48" x 88".

### Models 30 K W and 40 K W—110-220 Volts

Engine—30 K W model, 4 cyl., speed, 800 r. p. m.; 40 K W model, 6 cyl., 800 r. p. m.

Cooling—Radiator.

Governor—Mechanical.

Fuel System—Stewart or gravity.

Generator—General Electric, 110-220 volts, 30 K W model, 30,000 watts capacity; 40 K W model, 40,000 watts capacity.

Battery—Portable type and used with or without battery.

Starting—Push button.

Floor Space—30 K W model, 54" x 106"; 40 K W model, 54" x 128".

Shipping Weight—30 K W model, 4,400 lb.; 40 K W model, 5,100 lb.

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"Meyerlite" Light & Power Plant
1,000 Watts, 32 Volts

## MEYERLITE CORPORATION

**Minneapolis, Minn.**

**Trade Name "Meyerlite"**

**(No. of Models 1)**

Engine—1 cyl., 4 cycle, 3½ h. p.; speed, 1,150 r. p. m.

Cooling—Air and water cooled.

Governor—Throttle.

Fuel System—Fuel tank in base.

Generator—Own make, 1,000 watts, 40 volts; capacity, 50 20-watt lamps.

Switchboard—Ammeter, combination starting switch and automatic cut-out.

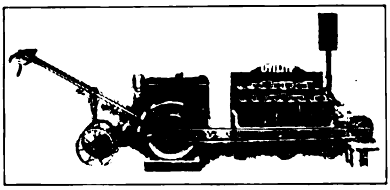
Battery—16 cell, sealed glass jar type, 5 sizes: 95, 140, 190, 235 and 277 A. H. capacity.

Starting—Semi-automatic.

Stopping—Semi-automatic.

Floor Space—20" x 30".

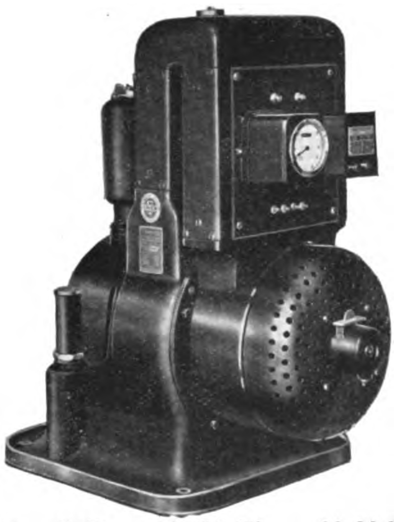
Shipping Weight—Without battery, 500 lb.; with battery, 1,400 lb.



"Utilite" Plant
700 Watts, 32 Volts

**MIDWEST ENGINE COMPANY**
**Indianapolis, Ind.**
**Trade Name, "Utilite"**
**(No. of Models 1)**

Engine—1 cyl., 4 cycle, 4 h. p.; speed, 1,200 r. p. m.
Cooling—Thermo syphon circulation.
Governor—Funk.
Fuel System—Gasoline.
Generator—2 pole, 700 watts, 32 to 38 volts.
Switchboard—Automatic regulator, gauge, switch and fuses.
Battery—16 cells, 32 volts, Western Electric.
Starting—Hand.
Floor Space—45" x 150".
Shipping Weight—120 lb.



"Owen" Plant 1,280 Watts, 32 Volts

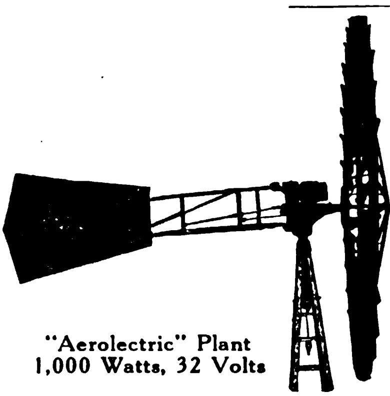
**R. M. OWEN & COMPANY, INC.**
**Chicago, Ill.**
**"Trade Name "Owen"**

Engine—Rotary valve type, 1 cyl., 3½ h. p.; speed, 1,350 r. p. m.
Cooling—Water, thermo syphon circulation.
Governor—Fly-ball, throttling type.
Fuel System—Gasoline.
Generator—1,280 watts, 32 volts.
Switchboard—Automatic.
Battery—Globe.
Starting—Push button.
Stopping—Automatic.
Floor Space—18" x 23½".
Shipping Weight—525 lb., less battery.

(No Illustration)

**PERFECTION HOIST & ENGINE CO.**
**Two Rivers, Wis.**
**Trade Name, "Perfectlite"**
**(No. of Models 5)**

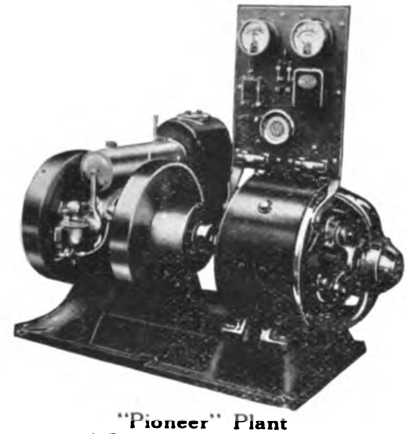
Engine—1 cyl., 5 h. p.; speed, 1,100 r. p. m.
Cooling System—Water, thermo syphon with radiator.
Governor—Electrical.
Fuel System—Holley carburetor and impulse tank.
Generator—1,500 watts, 32 volts.
Switchboard—Jewel.
Battery—"Perfectlite."
Starting—Semi-automatic.
Stopping—Automatic.
Floor Space—36" x 19".
Shipping Weight—Without battery, 700 lb.; with battery, 1,250 lb.



"Aerolectric" Plant
1,000 Watts, 32 Volts

**PERKINS CORPORATION**
**Mishawaka, Indiana**
**Trade Name, "Aerolectric"**
**(No. of Models 1)**

Engine—Wind power, 14 foot Perkins steel wind wheel on 50 foot tower.
Cooling—None.
Governor—Automatic, moves wheel out of wind as speed increases.
Fuel System—Wind power.
Generator—Westinghouse, 1 K W, 32 volts.
Switchboard—Ammeter, voltmeter, switch, relays, and fuse block (Globe Battery Co.).
Battery—U. S. L., 16 cells, 32 volts, 240 ampere hour capacity.
Shipping Weight—Domestic, windmill (includes main casting and generator) 1,266 lb. Batteries, 680 lb. Tower, 1,530 lb. Panel board, 40 lb.

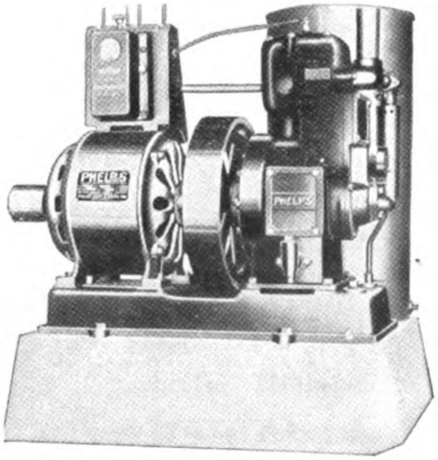


"Pioneer" Plant
1,500 Watts, 32 Volts

**PIONEER ELECTRIC CO., St. Paul, Minn.**

**(No. of Models 1)**

Engine—1 cyl., 5 h. p.; speed, 700 r. p. m.
Cooling—Water, thermo syphon circulation.
Governor—Ball type.
Fuel System—Gravity.
Generator—1,500 watts, 32 volts.
Switchboard—Voltmeter, ammeter, circuit breaker, rheostat and switches.
Battery—Sealed glass jar types, sizes from 60 A. H. to 210 A. H. standard rating.
Starting—Semi-automatic and crank.
Stopping—Hand.
Floor Space—28" x 40"; height, 36".
Shipping Weight—800 lb., less battery.

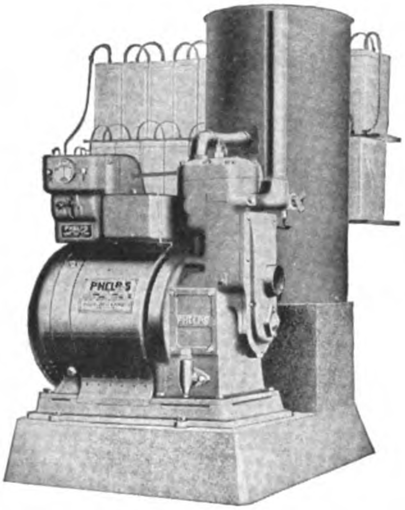



Phelps 1500 Watts, 32 Volts

**PHELPS LIGHT AND POWER CO.**

**Rock Island, Ill.**
**Trade Name "Phelps"**
**(No. of Models 2)**

Engine—1 cyl., 3½ h. p.; speed, 1,265 r. p. m.
Governor—Centrifugal.
Fuel System—Vacuum lift vaporizer, tank in base.
Generator—1,500 watts, 32 volts.
Control Board—Manually operated; starting and stopping lever, including an automatic stop.
Starting—Manually operated control lever.
Stopping—Manually or automatic by means of an overcharge relay when batteries are fully charged.
Floor Space—36" x 18"; height, 30".
Shipping Weight—589 lb. without battery.




Phelps Model T Plant, 1000 Watts, 32 Volts

**Phelps Model T**

Engine—1 cyl., 3 h. p.; speed, 1,350 r. p. m.
Governor—None.
Fuel System—Vaporator.
Generator—Own make, 1,000 watts.
Control Board—Phelps controller.
Starting—Manual, battery cranking.
Stopping—Automatic and manual.
Cooling System—Thermo syphon.
Battery—S. O. S. 65 A. H., 112 A. H., 140 A. H., 190 A. H.
Floor Space—15" x 24".
Shipping Weight—Without battery, 345 lb., with battery: 65 A. H., 580 lb.; 112 A. H., 564 lb.; 140 A. H., 840 lb.; 190 A. H., 960 lb.

## PREMIER ELECTRIC COMPANY

**Chicago, Illinois**

**(No. of Models 2)**

(No Illustration)

Engine—1 cyl., 1½ h. p.
Cooling—Water.
Governor—Throttling.
Fuel System—Gasoline or kerosene.
Generator—Comet, 800 watts.
Switchboard—Jewel.
Battery—Own make.
Starting—Semi-automatic.
Stopping—Semi-automatic.
Floor Space—12 square feet.
Shipping Weight—Without battery, 1,050 lb.; with battery, 1,400 lb.

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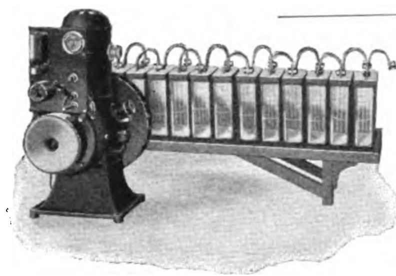
## REGAL GASOLINE ENGINE CO.,

**Coldwater, Mich.**

**Trade Name, "Regalite"**

**(No. of Models 1)**



"Regalite" Plant
750 Watts, 32 Volts

Engine—1 cyl., 2 h. p.; speed, 700 r. p. m.
Cooling—Air.
Fuel System—Gasoline or kerosene.
Generator—750 watts, 32 volts.
Switchboard—Mounted on generator, usual instruments, voltmeter, automatic cut-out, etc.
Battery—16 cells, 32 volts.
Starting—Hand or by switch from battery.
Floor Space—13½" x 15½".
Shipping Weight—500 lb.

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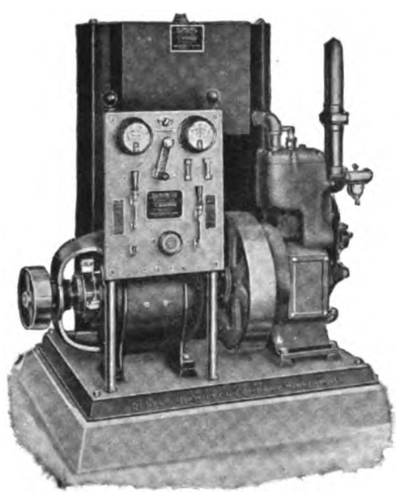
## ROBERTS-HAMILTON COMPANY

**Minneapolis, Minn.**

**Trade Name, "Rohaco"**



"Rohaco" Plant
1,500 Watts, 32 Volts

Engine—1 cyl., 3½ h. p.; speed, 1,200 r. p. m.
Cooling—Water syphon system.
Covernor—Fly-ball throttling.
Fuel System—Gravity.
Generator—Phelps, 1,500 watts, 32 volts.
Switchboard—Voltmeter and ammeter.
Battery—National 170 ampere hour.
Starting—Hand.
Stopping—Hand.
Floor Space—26" x 31".
Shipping Weight—Without battery, 500 lb.; with battery, 1,000 lb.

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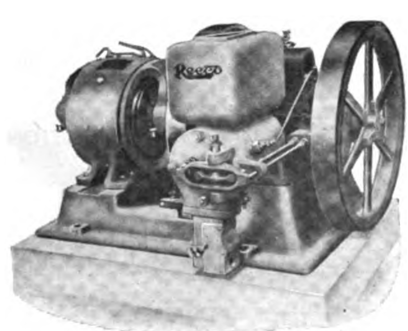
## RURAL ELECTRIC EQUIPMENT CO.,

**Canton, Pa.**

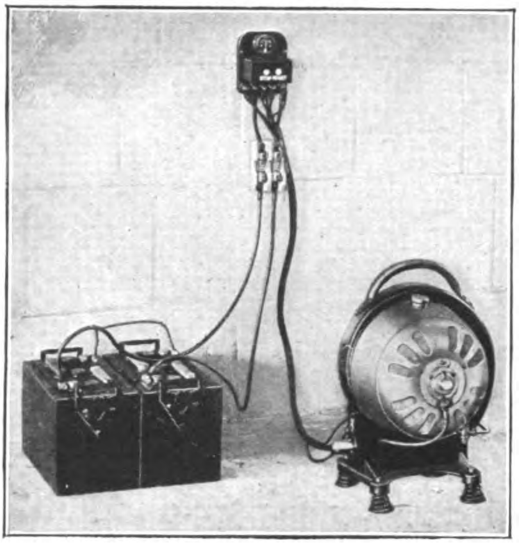
**Trade Name, "Reeco"**

**(No. of Models 1)**




"Reeco" Plant
1,500 Watts, 32 Volts

Engine—1 cyl., 3 h. p.; speed, 475 r. p. m.
Cooling—Water (Hopper).
Governor—Centrifugal in flywheel.
Ignition—High-tension magneto.
Fuel System—Suction feed.
Generator—Four-pole shunt wound, 1,500 watts, 32 volts.
Switchboard—Voltmeter, ammeter, fuses, starting switch and rheostat.
Battery—16 cells, 32 volts.
Starting—Hand.
Floor Space—Approximately 4' x 4'.
Shipping Weight—Approximately 1,000 lb., less battery.



"Homelite" Plant
400 Watts

## THE SIMMS MAGNETO COMPANY

**East Orange, N. J.**

**Trade Name, "Homelite"**

**(No. of Models 1)**

Engine—1 cyl., ½ h. p.; speed, 1,450 r. p. m.
Cooling—Forced air.
Governor—None.
Fuel System—Carburetor or mixing valve.
Generator—"Simms," 400 watts.
Switchboard—Ammeter or ampere hour meter.
Battery—Prestolite.
Starting—Semi-automatic.
Stopping—Automatic.
Floor Space—14" x 14".
Shipping Weight—Without battery, 175 lb.; with battery, 385 lb.

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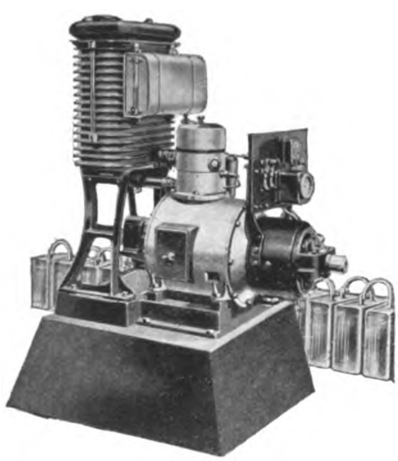
## STEARNS MOTOR MFG. COMPANY

**Ludington, Mich.**

**Trade Names, "Deluxe" and "Simplex"**

**(No. of Models 2)**



"Deluxe" Plant
750 Watts, 32 Volts

### "Deluxe" Plant

Engine—1 cyl., 4 cycle.
Cooling—Water, thermo percolating system.
Governor—Electric.
Generator—Two pole type, 750 watts, 32 volts.
Switchboard—Double line switch, starting switch, magneto switch, automatic cut-out, ampere hour meter and magneto.
Battery—16 cells, 90-110 ampere hour, glass jar battery.
Starting—Push button.
Stopping—Automatic.
Shipping Weight—670 lb., less battery.

### "Simplex" Plant

Engine—1 cyl., 4 cycle.
Cooling—Water, thermo percolating system.
Governor—Electric.
Generator—Two pole type, 750 watts, 32 volts.
Starting—Hand.
Floor Space—22" x 36".
Shipping Weight—670 lb.

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## SOLAR FARM LIGHT CORPORATION

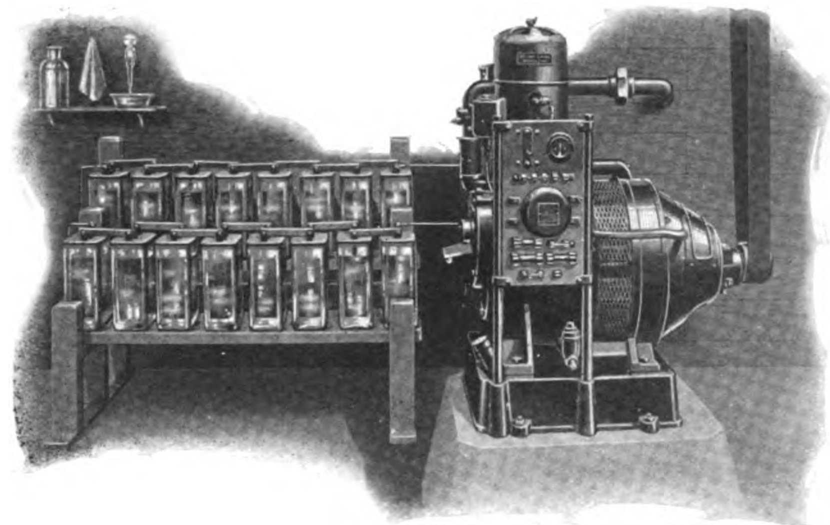
**Pittsburgh, Pa.**

**Trade Name, "Solar"**

**(No. of Models 1)**

(No Illustration)

Engine—1 cyl., 3.6 h. p.; speed, 1,300 r. p. m.
Cooling System—Air cooled.
Governor—Flywheel.
Fuel System—Suction from tank in base.
Generator—1½ K W.
Battery—32 volts, 160 A. H.
Starting—Hartman controller.
Floor Space—15" x 22".



# *Western Electric*
## Power & Light

dealers find it easy to sell this powerful Western Electric farm plant because:

- it is made by a company that has been making electrical equipment since 1869.
- it has a pulley from which mechanical power can be secured either at the same time the battery is charged or independently.
- all parts are easy to get at.
- the engine runs on kerosene and is air-cooled.
- it gives the "Tapering Charge" which makes the battery last longer.

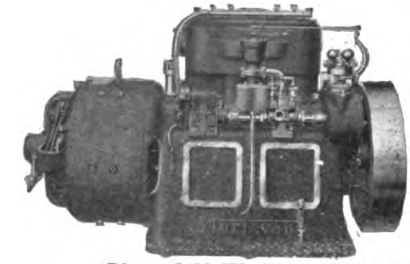
Besides lighting the farm with safe and convenient electric light, the Western Electric Power & Light Outfit is large enough to operate labor-saving and comfort-creating appliances such as Automatic Water Systems, Utility and Stationary Motors, Clothes Washers, Vacuum Sweepers, Dishwashers, Fans, Irons.

Because Western Electric dealers sell **all** these essentials to modern farm equipment,—each one a **Western Electric Appliance,**—they enjoy exceptional opportunities for profitably and extensively developing their business. Buyers look for the name that insures **standardized satisfactory service!**

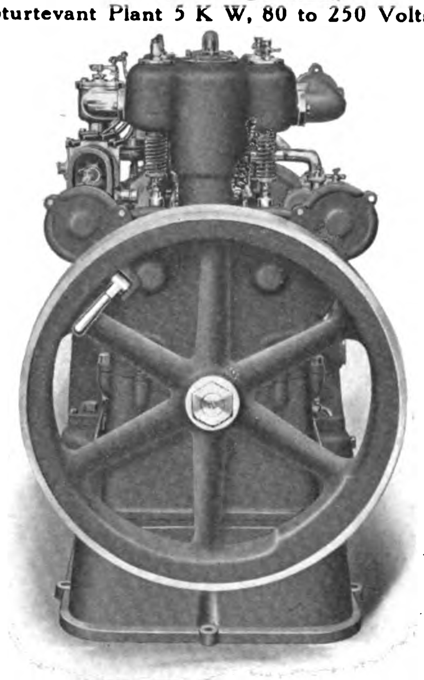
There is ample profit in being a Western Electric dealer, and opportunities to obtain desirable territories are still open to men who can sell.

## *Western Electric Company*

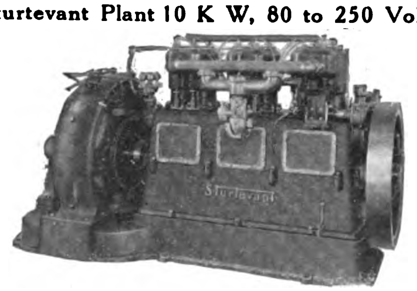
195 Broadway, New York City



Sturtevant Plant 5 K W, 80 to 250 Volts



Sturtevant Plant 10 K W, 80 to 250 Volts



Sturtevant Plant 15 K W, 110 to 250 Volts

## B. F. STURTEVANT COMPANY,

**Hyde Park, Boston, Mass.**

**Trade Name, "Sturtevant"**

(No. of Models 3)

### 5 K W Set

Engine—4 cyl.; speed, 900 r. p. m.
Cooling—Water, pump circulation.
Governor—Centrifugal.
Fuel System—Pump or gravity.
Generator—5 K W, 80 to 250 volts.
Switchboard—Optional.
Starting—Hand.
Floor Space—51½" x 20½".
Shipping Weight—1,750 lb.

### 10 K W Set

Engine—4 cyl.; speed, 750 r. p. m.
Cooling—Water, pump circulation.
Governor—Centrifugal.
Fuel System—Pump or gravity.
Generator—10 K W, 80 to 250 volts.
Switchboard—Optional.
Starting—Hand.
Floor Space—62½" x 31½".
Shipping Weight—3,050 lb.

### 15 K W Set

Engine—6 cyl.; speed, 750 r. p. m.
Cooling—Water, pump circulation.
Governor—Centrifugal.
Fuel System—Pump or gravity.
Generator—15 K W, 110 to 250 volts.
Switchboard—Optional.
Starting—Hand.
Floor Space—78" x 35".
Shipping Weight—4,150 lb.

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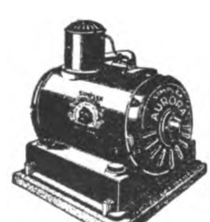

"Simplex Aurora" Full-Automatic Plant, 1,500 Watts, 32 Volts

## SIMPLEX UTILITIES CORPORATION

**New York, N. Y.**

**Trade Name, "Simplex Aurora"**

(No. of Models 1)

Engine—1 cyl.; speed, 900 r. p. m.
Cooling—Air.
Fuel System—Pump.
Generator—General Electric, 4-pole, 1,500 watts, 32 volts.
Switchboard—Full automatic, completely enclosed, mounted on battery stand.
Battery—16 cells "Multiple" make.
Starting—Fully automatic.
Floor Space—20¾" x 21".
Shipping Weight—Complete without batteries, 530 lb.

"Sunbeam Farm-Lite" Plant
650 Watts, 32 Volts

## SUNBEAM ELECTRIC MFG. CO.,

**Evansville, Ind.**

**Trade Name, "Sunbeam"**

(No. of Models 1)

Engine—1 cyl.; speed, 1,400 r. p. m.
Cooling—Water.
Fuel System—Gravity feed.
Motor-Dynamo—650 watts, 32 volts.
Switchboard—Automatic switches, fuses, hand switch, ammeter.
Battery—14 cells, 32 volts.
Governor—Electro-magnetic.
Starting—Automatic or hand.
Stopping—Automatic.
Floor Space—23" x 15".
Shipping Weight—300 lb., less batteries.

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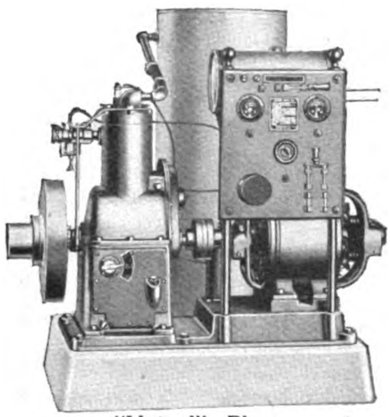


"United" Plant
1,000 Watts, 32 Volts

## UNITED ENGINE COMPANY

**Lansing, Mich.**

**Trade Name, "United"**

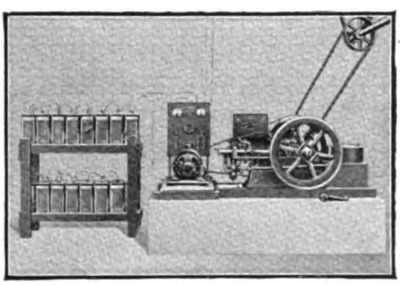
(No. of Models—Various sizes in both direct drive and belt driven)

**Single Unit Direct Connected 32 Volt Plants**

Engine—1 cyl., 3½ h. p.; speed, 1,150 r. p. m., with pulley for power use.
Cooling—Water, thermo syphon circulation.
Governor—Mechanical throttling.
Fuel System—Float feed.
Generator—4 pole, shunt wound, 1,000 watts, 30-40 volts.
Switchboard—Voltmeter, ammeter, rheostat, automatic cut-out and necessary switches and fuses.
Battery—16 cells, sealed glass jar, lead acid type, in three sizes: plant No. 90, 90 A. H., 2,880 watt hours; plant No. 120, 120 A. H., 3,840 watt hours; plant No. 180, 180 A. H., 5,660 watt hours.

**Belt Driven, 32 Volt Plants**

Generator—1,000 watts, 30-40 volts, shunt wound, 4 pole, 5½ inch pulley.
Switchboard—Voltmeter, ammeter, rheostat, automatic cut-out, and all necessary switches and fuses.
Battery—16 cells, sealed glass jar, lead acid type, in three regular sizes: plant No. 2, 90 A. H., 2,880 watt hours; plant No. 3, 120 A. H., 3,840 watt hours; plant No. 4, 180 A. H., 5,660 watt hours.



"United" Belt Driven Plant
1,000 Watts, 32 Volts

**Belt Driven, 110 Volt Plants**

Range from 1½ K W to 5 K W with 56 cell storage batteries of suitable capacity.

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## WESTERN CABLE AND LIGHT COMPANY

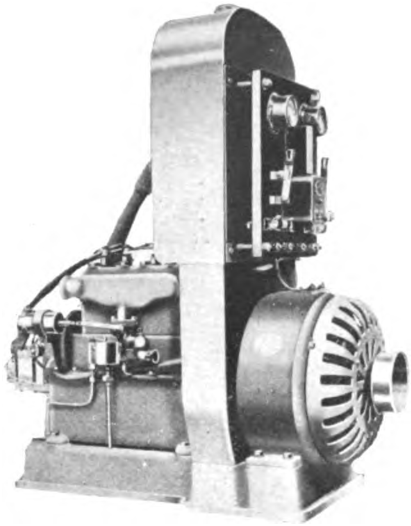
**Baldwin, Wisconsin**

**Trade Name, "'Western Cable"**

(No. of Models—1 direct connected. All sizes of belted outfits)

(No Illustration)

Engine—1 cyl.; speed, 300 to 1,200 r. p. m.
Cooling—Water cooled.
Governor—Throttling.
Fuel System—Kerosene or gasoline.
Generator—Depending on the model.
Switchboard—Roller-Smith.
Battery—Own make.



"Unimote" Plant
2 K W, 32 or 110 Volts

## UNIVERSAL MOTOR COMPANY

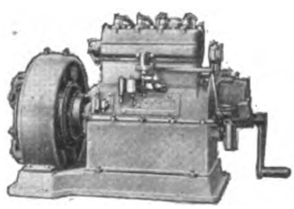
**Oshkosh, Wis.**

**Trade Names, "Universal" & "Unimote"**

**(No. of Models 2)**

### Unimote Outfit—2 K W

Engine—4 cyl., 4 cycle; speed, 1,250 r. p. m.
Cooling—Water, thermo syphon circulation.
Governor—Electric.
Fuel System—Gasoline tank in sub-base, pump supplies carburetor, overflow provided.
Generator—2 K W, 32 or 110 volts.
Switchboard—Voltmeter, ammeter, main line switch, line fuse, battery fuse, cutout, starting and stopping buttons.
Battery—16 cells, 180 ampere hour.
Starting—Push button.
Floor Space 38" x 16", 38" high.
Shipping Weight—500 lb., less battery.



"Universal" Plant
4 K W, 64, 110 or 125 Volts

### Universal Outfit—4 K W

Engine—4 cyl.; speed, 1,100 r. p. m.
Cooling—Cooling apparatus not supplied unless especially ordered.
Governor—Centrifugal.
Fuel System—Optional with purchaser.
Generator—Multiple pole type, 4 K W, 64, 110 or 140 volts.
Switchboard—Voltmeter, ammeter, rheostat, pilot lamp and switch.
Battery—32 cells for 60 volt set, 53 cells for 110 and 125 volt set.
Starting—Hand crank built in gear cover, push button when battery is ordered.
Floor Space—42" x 19½"; height, 23½".
Shipping Weight—With electric starter, 1,650 lb.

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## UNIVERSAL PRODUCTS COMPANY

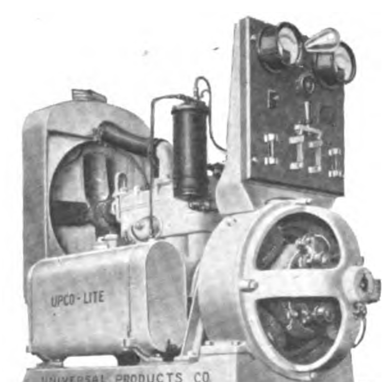
**Oshkosh, Wis.**

**Trade Names "Universal" & "Upco-Lite"**

(No Illustration)

### Universal 1 K W Plant

Engine—1 cyl.; speed, 1,200 r. p. m.
Cooling—Water, thermo syphon circulation.
Governor—Centrifugal.
Fuel System—Gravity feed.
Generator—4 pole, 1,000 watts, 32 volts.
Switchboard—Cut-out, starting and stopping switches, and instruments.
Battery—16 cells, 32 volts, capacities 90 to 240 ampere hours.
Starting—Push button.
Stopping—Automatic.
Floor Space—30" x 20"; height, 38".
Shipping Weight—900 lb.




"Upco-Lite" 5 K W Plant
5 K W, 110 Volts

### Upco-Lite 5 K W Plant

**(Made in 5-10-15-25 K W Sizes)**

Engine—4 cyl., 4 cycle; speed, 800 r. p. m.
Cooling—Water, thermo syphon circulation.
Governor—Centrifugal.
Fuel System—Suction, Stewart vacuum tank.
Generator—Multipolar type, 5 K W, 115 volts.
Switchboard—Volt and ammeter, pilot lamp, circuit breaker, short circuit switch and field rheostat.
Starting—Battery equipped, push button without battery, either mechanical or electrical.
Floor Space—55" x 30"; height, 40".
Shipping Weight—1,500 lb.

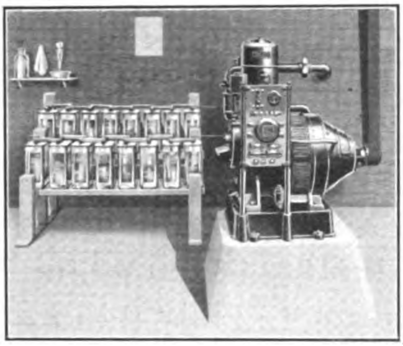
## WESTERN ELECTRIC COMPANY

**New York, N. Y.**

**Trade Name, "Western Electric"**

### Direct Connected Outfit

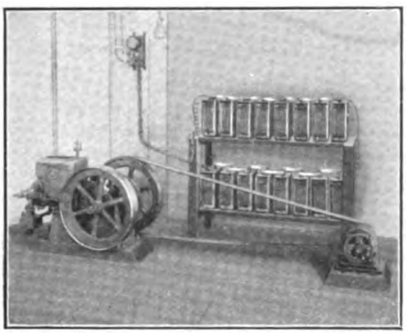
Engine—1 cyl., 4 cycle; speed, 1,000 r. p. m.
Cooling—Air circulation.
Fuel System—Kerosene.
Generator—32 volts, 40 amperes.
Control Board—Semi-automatic.
Battery—16 cells, 32 volts, two capacities, 90 and 180 ampere hour, 8 hour rating.
Starting—Semi-automatic.
Floor Space—29" x 36".
Shipping Weight—1,300 and 1,800 lb.



"Western Electric" "DC" Outfit
1,250 Watts, 32 Volts

### 32 Volt—"R" Type

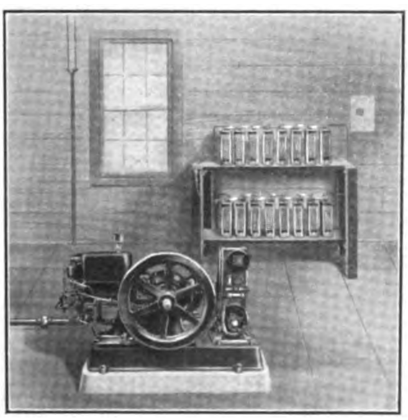
Engine—1 cyl.; type 5-R-90, 1½ h. p.; speed, 650 r. p. m.; type 7-R-90, 3 h. p.; speed, 600 r. p. m.
Cooling—Water.
Fuel System—Kerosene and gasoline.
Generator—5-R-90 outfit, 500 watts, 32 volts; 7-R-90 outfit, 700 watts, 32 volts.
Control Board—Semi-automatic.
Battery—5-R-90 outfit, WEG-90 battery, 16 cells; 7-R-90 outfit, WEG-90 battery, 16 cells, 8 hour rating.
Starting—Hand.
Shipping Weight—5-R-90, 900 lb.; 7-R-90, 1,000 lb.



"Western Electric "R" Type Plant
500 and 700 Watts, 32 Volts

### "CBC" Outfit

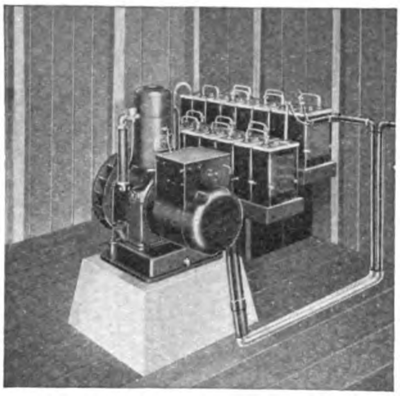
Engine—1 cyl., 4 cycle; type 5-CBC-90, 1½ h. p., speed, 650; type 7-CBC-90, 3 h. p., speed, 600; type 10-CBC-180, 3 h. p., speed, 475.
Cooling—Water.
Fuel System—Kerosene and gasoline.
Generator—5-CBC-90 outfit, 500 watts, 35-42 volts; 7-CBC-90 outfit, 700 watts, 35-42 volts; 10-CBC-180 outfit, 1,000 watts, 35-42 volts.
Control Board—Semi-automatic.
Battery—5-CBC-90 outfit, 16 cells, 90 ampere hour; 7-CBC-90 outfit, 16 cells, 90 ampere hour; 10-CBC-180 outfit, 16 cells, 180 ampere hour; 8 hour rating.
Starting—Hand.
Shipping Weight—5-CBC-90 outfit, 1,400 lb.; 7-CBC-90 outfit, 1,600 lb.; 10-CBC-180 outfit, 2,100 lb.



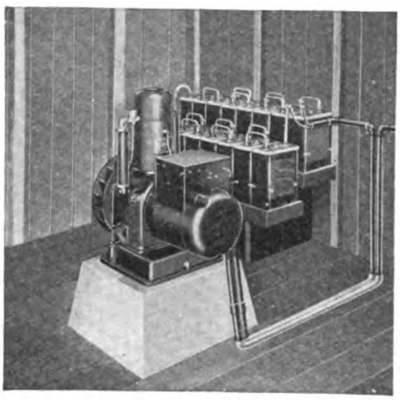
Western Electric "CBC" Outfit
500, 700 and 1,000 Watts, 32 Volts

### 110 Volt Belted Outfits

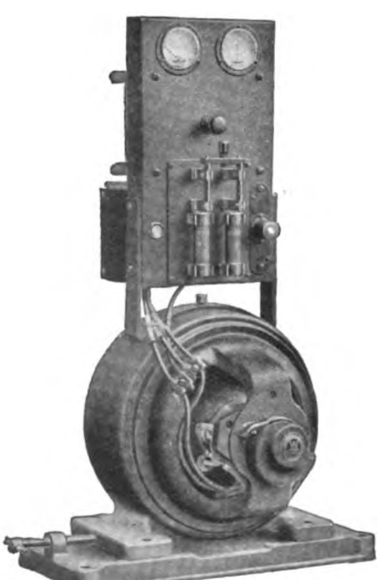
Engine—1 cyl., 7 to 20 h. p.; 4 cycle, except 12 and 14 K W outfits which are 2 cycle; speed, 475 to 260 r. p. m.
Cooling—Water.
Fuel System—Kerosene, gasoline and crude oil.
Generator—1¾ K W to 14 K W, 110 volts.
Control Board—Hand operated.
Battery—56 cells, 110 volts; capacity, 90 to 360 ampere hours, 8 hour rating.
Starting—Hand.
Shipping Weight—1,800 to 17,150 lb.



Westinghouse Model E-30
750 Watts, 32 Volts



Westinghouse Model E-60
1500 Watts, 32 Volts



Belted Type Westinghouse Plant

## WESTINGHOUSE ELECTRIC & MFG. CO.

**East Pittsburgh, Pa.**

**Trade Name "Westinghouse Light & Power Plant"**

### Model E-30 (32 Volt) Unit Type

Engine—1 cyl., 4 cycle; speed, 1,250 r. p. m.
Cooling—Air cooled, fan in flywheel.
Fuel System—Suction lift; kerosene, gasoline, natural gas. Fuel tank in engine base.
Generator—2 pole, sleeve type, shunt wound for charging, series starting winding, 750 watts, 36 volts.
Control Box—Dead faced on generator frame; no meters, no gauges.
Battery—16 cells, 32 volts, 4,500 watt hours at 8 hour rate.
Starting—Self starting with switch.
Stopping—Automatic by battery meter.
Floor Space—25" x 16⅝"; height, 29⅛".
Shipping Weight—425 lb. without battery.

### Model E-60 (32 Volt) Unit Type

Engine—1 cyl., 3 h. p.; speed, 1,200 r. p. m.
Cooling—Air cooled, fan in flywheel.
Governor—Regulation mechanical speed type.
Fuel System—Suction lift; kerosene, gasoline, natural gas. Fuel tank in engine base.
Generator—Sleeve type, shunt with series starting winding; 1,500 watts, 32 volts.
Control Box—Dead faced on generator frame; no meters, no gauges.
Mechanical Power—Pulley 3" x 5" on flywheel.
Battery—16 cells, 32 volts, 4,500 watt hour battery; 6,000 watt hour battery, 8 hour rate.
Starting—Self starting with switch.
Stopping—Automatic by battery meter.
Floor Space—29¾" x 19½"; height, 34½".
Shipping Weight—500 lb. without battery.

### Belted Type—32 Volt Service

Composed of semi automatic control panel, generator, sliding base and pulley.
Generator—Capacities: 500, 600, 850, 1,000 and 1,500 watts.
Control Panel—Ammeter, voltmeter, rheostat, starting and stopping switches, line switch and a reverse current relay.
Floor Space—500 watt, 14" x 14"; height, 28"; 1,500 watt, 19" x 25"; height, 32".
Shipping Weight—500 volt set; 105 lb.; 600 volt 115 lb.; 850 volt, 155 lb.; 1,000 volt, 200 lb.; 1,500 volt, 250 lb.

# Wind Power Plants

THE idea of utilizing the power of the wind to generate electricity is practically as old as our knowledge of the electric generator itself. The wind has been used as a source of power for thousands of years and so it was natural that when the first electric dynamos or generators were built, that the plan of harnessing a wind wheel to them should have presented itself. The invention of the storage battery made this appear still more feasible, because except in those latitudes where regular trade winds blow at an almost uniform velocity during certain hours every day, the average wind is not sufficiently regular to make it practical to take power direct from the generator. There would be too great a variation in the current, whether a high wind or only a gentle breeze is blowing.

While the idea of utilizing wind power for generating electric current and storing it in batteries is half a century old, like many other valuable ideas it was first presented many years in advance of its time. The electric generator, the storage battery and the wind wheel itself had to undergo years of development before the three could be combined into a practical working unit to be marketed on a commercial basis. This point has been reached today, but thirty-five years of experimenting by amateur electricians and others sufficiently interested in the subject to go to the expense of building home made plants, have preceded it.

The term "home made plant" explains why the majority of these experiments were not sufficiently successful to encourage the commercial development of the idea. Many of these early experimenters were simply kitchen mechanics who had little or no knowledge of wind pressures, surfaces and speeds required to develop a certain amount of power, nor were they familiar with the great losses of power in transmission through friction.

### Crude Workmanship Wasted Most of the Power

With few exceptions, and the successful exceptions have been giving service for a good many years, none of these experimental plants was either designed or built for the purpose. It was simply assembled out of any materials available. A windmill of any type and size that could be had was used with little or no idea as to the amount of power it would develop or the wind velocities required to make it develop any power. Many of the windmills turned out by manufacturers in earlier years were notoriously crude pieces of mechanism. If they accomplished what they were purchased for, usually the maintenance of a good supply of water, they were considered perfectly satisfactory regardless of how much power they wasted in the process.

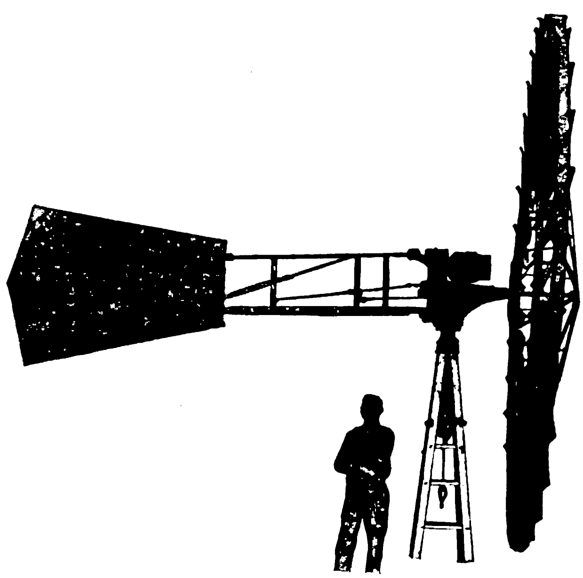
With such windmills as prime movers, the experimenter either had to build his own dynamo or buy whatever he could on the open market, trusting to obtain a generator that would come somewhere near his requirements. There weren't many experimenters competent to make their own dynamos, or able to pay someone else to make one to order for the purpose. To add to the disadvantages of having an inefficient windmill and a misfit generator, the experimenter had to couple the two through gears and shafting or belting for the power transmission. This was strictly home made so that very little of the small amount of power generated by the wind wheel ever survived to reach the dynamo. It was lost in transmission owing to the great amount of friction caused by poor bearings, aggravated by inaccurately cut gears plus lack of alignment in the bearings themselves and the fact that the power had to go through so many steps before reaching the generator. It was highly discouraging to provide so much plant—that is, a windmill, a transmission, dynamo and storage battery, involving a great outlay at that time, and get so little power in return for it. It was on this account that a more or less general impression arose that it was not practical to

attempt to develop electric power with the aid of the wind. Like many other things it was finally considered to be excellent theory but not good practice.

### Ordinary Windmill Will Not Do

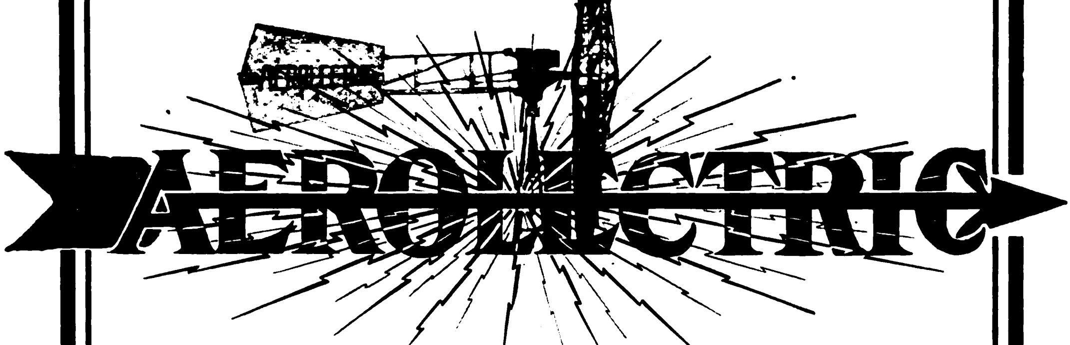
Some of the experiments referred to above, however, were carried out by competent engineers and financed by manufacturers who saw the great possibilities of the windwheel generator if properly developed according to engineering standards and manufactured on a commercial scale. They realized at once that it is not possible to take an ordinary windmill, hook an ordinary dynamo to it by any means available and produce a practical electric generating plant that will keep a good-sized storage battery charged, any more than it is possible to take an ordinary stationary gasoline engine, put it on a wagon body and make a practical motor truck. Don't waste time writing to a manufacturer that you have a fine windmill that runs almost every day in the year and that you ought to be able to develop a large amount of electric power with it if you can buy the right kind of a generator. The preceding paragraphs on the results of the average experimenter's work in this field will show you pretty plainly why it can't be done.

It is necessary to design a special windwheel for the purpose; then to design a special generator to suit the characteristics of this windwheel, likewise a special transmission or gear box between the generator and the windwheel, so that all three will act as a unit, then, to eliminate friction losses, the windwheel, the gear set and the generator must all be accurately mounted on a precision type of anti-friction bearing—bearings whose friction loses are measured in fractions of 1 per cent., rather than the 10 to 25 per cent. power losses caused by plain bearings that are not in alignment. It hasn't been found practical to generate current by means of a dynamo on the ground to which the power of the windwheel is transmitted through gears, shafts and belts, so that in designing the unit mentioned above it has been found necessary to mount the generator on the turn table with the wheel itself.



**Mounting of Westinghouse Generator on Perkins "Aerolectric," Showing Comparative Size of Outfit**

**FULLY TESTED** **PROVEN SUCCESS**




**LIGHT AND POWER FROM THE WIND**

# ELECTRICITY

## *A City Luxury*

## FOR EVERY FARM

**Added Sales - Extra Profits - Exclusive Territory**

***Write or Wire for Details***


**PERKINS CORPORATION**
**MISHAWAKA - - - INDIANA**
***SOLE MANUFACTURERS***
ESTABLISHED 1860

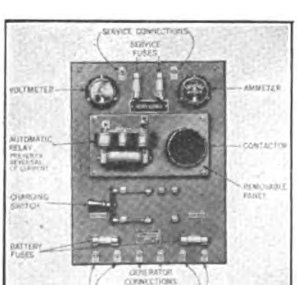
### Possibilities of Wind Power Development

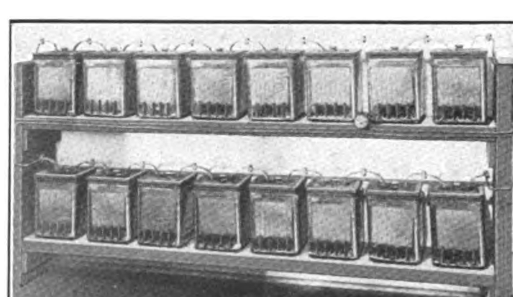
Power is the result of pressure against a given amount of surface times the speed at which that pressure is applied to the surface. Increasing the pressure, the surface or the speed or any combination of two or all three of these factors increases the power. These are well founded laws of mechanics that apply to the windmill just as they do to the steam or the gasoline engine. The wind pressures resulting from given wind velocities are just as well known as the pressures exerted on the piston of a steam or a gasoline engine at given compression and speed. Hence, there is no difficulty in designing a windwheel that will produce a certain amount of power at a given wind velocity, for example, 10 to 15 miles an hour average, this being the average of the wind velocity during a very large part of the year in most of the United States.

The next important problem is to have the wheel of such a size that it will not develop an excessive amount of power when the wind velocity increases to 25 or 30 miles an hour, and large enough so that it will still generate a practical amount of power when the wind falls to a point between 5 and 10 miles an hour. The former is readily taken care of by the governor of the windwheel itself and by the special design of the generator which prevents its voltage exceeding a given standard regardless of the speed at which it is driven. The latter requirement, however, that of producing sufficient power to generate current at very low winds has only been solved by resorting to the same high standards of precision in machining and to the use of anti-friction bearings, that is, roller or ball-bearings, that have made the modern automobile possible. All of these requirements have been successfully met in wind-driven plants that are now being placed on the market on a commercial scale. A brief description of one of these plants is given a little further along. Before taking this up, further reference is made to the possibility of developing electric power with the aid of the wind, likewise the possibility of established dealers in this field adding to their income by the sale of this type of plant.

### Study Your Own Conditions

To answer satisfactorily the question: "Can wind-driven plants be sold to advantage in my territory?"—It is only necessary to make a study of the conditions which prevail in your location. If there are many windmills in use there now for pumping service and they are giving satisfaction in this respect, the prospects of selling wind-driven electric plants are that much better. There is always less sales resistance in selling a man something with which he is familiar. But the fact that there may be pumping wind mills in your territory which have not given particularly satisfactory service is no drawback. Study the conditions and it will be a very easy matter for you to point out to their owners why they have not given the kind of service he expected.





**Automatic Switchboard and 16-Cell 240 A.-H. Battery of Perkins "Aerolectric"**

In all probability you will find that the wheel is entirely too small to pump the amount of water required. You will also find in the majority of instances that it is placed on entirely too small a tower to permit it to take advantage of the wind every day in the year, and that it is further hampered by being placed in a poor location. It is surrounded by trees and buildings, usually higher than the tower itself and so located that they act as a wind break. To be free from the influence of obstructions, the wheel itself should be at least 15 feet higher than surrounding houses and trees and it should preferably be placed 100 feet or more from these obstructions. When the wind strikes the side of the house it is diverted straight up into the air to a distance proportionate to the speed at which it is blowing. This results in the formation of a dead spot extending 50 to 100 feet or more from the other side of the house so that a windwheel placed there would be in comparatively calm air. The pumping windmill is at a disadvantage in this respect in that it is necessary to locate it directly over the well and the average farmer has always regarded the first cost more than he has the results to be produced.

The wind-driven electric plant is free from this disadvantage in that the tower may be located at a place where it will be entirely free from obstructions regardless of the distance this happens to be from the house and other buildings. If there is a hill or even a slight rise of land on the farm, this provides an excellent location and only involves a slight additional outlay for wire of heavier size to carry the current from the generator to the storage battery in the house. Don't let the customer pick the location for the windwheel just to please him and help make the sale go over easier. Pick it out yourself as the result of a study of the conditions and impress upon him the importance of putting it in the most advantageous location for year 'round service.

## Consult the Wind Table

In connection with your study of conditions in your territory, consult the accompanying wind table showing the number of hours of wind power available in the various states of this country. Disregarding winds of less than five miles per hour, which are not included in the table, the latter shows that anywhere from 40 to 85 per cent. or more of the total time in the year is available for generating electric power, since a wind of six miles per hour or greater is available on all except very few days in the year. The longest period of calm recorded by the U. S. Weather Bureau is that given for New York State and is just a little over ten days. The next longest period of calm recorded is somewhat over seven days. It is a very unusual condition to have a calm last for more than 48 hours in any part of the country and this only occurs during mid-summer when the demand for lighting current is lowest.

From October to June there is on the average far more wind than can be used. There is so much wind available that two or three sets of batteries of the capacity used with a plant of this size could be kept fully charged. During these months it would not be necessary to permit the wheel to run more than one or two days a week at the most; one day would usually be sufficient since the batteries supplied have sufficient capacity to provide current for lighting and small power purposes on the average farm to last ten or eleven days. This opens further sales possibilities in that the dealer may sell satisfied owners of wind driven plants two sets of storage batteries, connecting them up to the switchboard and the service lines so that each set of cells may be charged alternately.

For example, when one battery is fully charged, it is switched on to the service lines and current used from it. In the meantime, the other battery is connected to the generator and put under charge. This would be an advantage during the three summer months when the wind is lightest and

# Table of Annual Wind Velocities

**(U. S. Government Weather Bureau, Washington, D. C.)**

## Showing the Number of Hours per Year in Each State Available for Generating Electric Power—Available Range 6 to 30 Miles per Hour—365 × 24 = 8760 Total Hours per Year

| | 0-5 m.p.h | 6-10 m.p.h. | 11-15 m.p.h. | 16-20 m.p.h. | 21 m.p.h. or over | Max. Period under 5 m.p.h. | Total hrs. useful wind per year |
|---|---|---|---|---|---|---|---|
| Alabama | 1814 | 3729 | 2107 | 815 | 295 | 17* | 6946 |
| Arizona | 5587 | 2728 | 370 | 61 | 14 | 74 | 3173 |
| Arkansas | 2511 | 3701 | 1703 | 596 | 249 | 49 | 6249 |
| California | 4274 | 2857 | 1073 | 359 | 198 | 51 | 4487 |
| Colorado | 4884 | 2511 | 805 | 315 | 245 | 75 | 3876 |
| Florida | 3883 | 3777 | 934 | 146 | 20 | 25 | 4877 |
| Georgia | 1327 | 3476 | 2691 | 902 | 365 | 19 | 7434 |
| Idaho | 4347 | 2467 | 1204 | 494 | 249 | 119 | 4414 |
| Illinois | 2150 | 4399 | 1674 | 433 | 105 | 23 | 6610 |
| Indiana | 948 | 3063 | 2789 | 1228 | 732 | 25 | 7812 |
| Iowa | 2928 | 3671 | 1569 | 429 | 161 | 46 | 5830 |
| Kansas | 718 | 2398 | 2838 | 1650 | 1156 | 18 | 8042 |
| Michigan | 3025 | 3487 | 1457 | 541 | 261 | 36 | 5746 |
| Minnesota | 1185 | 2479 | 2327 | 1441 | 1328 | 21 | 7575 |
| Missouri | 839 | 3152 | 2851 | 1287 | 588 | 15 | 7878 |
| Montana | 3901 | 2611 | 1406 | 561 | 281 | 64 | 4859 |
| Nebraska | 3673 | 3203 | 1231 | 471 | 182 | 43 | 5087 |
| New Hampshire | 6294 | 1751 | 448 | 150 | 42 | 164 | 2391 |
| New Jersey | 2643 | 4347 | 1363 | 253 | 154 | 60 | 6117 |
| New York | 5655 | 2260 | 670 | 146 | 29 | 261 | 3105 |
| North Carolina | 2934 | 4021 | 1378 | 364 | 81 | 38 | 5744 |
| North Dakota | 1771 | 3051 | 2131 | 1062 | 745 | 25 | 6989 |
| Ohio | 1008 | 2809 | 2449 | 1423 | 1039 | 18 | 7720 |
| Oregon | 6041 | 2158 | 461 | 94 | 8 | 123 | 2721 |
| Pennsylvania | 4516 | 2821 | 1055 | 281 | 87 | 59 | 4244 |
| South Dakota | 3200 | 2508 | 1606 | 842 | 604 | 76 | 5560 |
| Tennessee | 2545 | 3460 | 1669 | 696 | 390 | 28 | 6215 |
| Texas | 2078 | 3503 | 1982 | 784 | 415 | 25 | 6684 |
| Utah | 3019 | 3268 | 1377 | 679 | 518 | 26 | 5842 |
| Virginia | 4863 | 2560 | 871 | 351 | 115 | 83 | 3897 |
| West Virginia | 5389 | 2506 | 658 | 161 | 46 | 91 | 3371 |
| Washington | 4404 | 2619 | 1106 | 389 | 246 | 125 | 4360 |
| Wisconsin | 1914 | 3754 | 2073 | 711 | 308 | 36 | 6846 |
| Wyoming | 3503 | 2446 | 1364 | 681 | 766 | 52 | 5257 |

*Experience has shown that average farm using electricity to light house and barns, pump water, run washing machine, milker, churn, fan and vacuum cleaner could run 11 days on one charge of a 240 A. H. 32-volt battery.

Maximum periods of calm per year, New York 10 days 21 hours; New Hampshire 6 days 20 hours. Eight states omitted from above, data not available.

during the remaining nine months of the year it would double the capacity of the plant since there is then so much wind power available that both sets of batteries could be kept fully charged practically all of the time. During these same nine months, the single battery ordinarily supplied with a wind driven plant will supply several times as much power as during the summer months, since it can be kept on charge as much of the time as desired, making it possible to run much larger motors.

### Practical Plants Now on the Market

The manufacturer whose advertising appears in this edition of the Year Book has taken into consideration all of the factors of the problems mentioned in preceding paragraphs and has developed a practical plant as the result of a great deal of study devoted to the subject. The following brief description of the plant will show how well it has been designed and built to meet the conditions outlined.

For example, the generator has been specially designed by the engineers of the Westinghouse Company who have given it the characteristics necessary for a variable speed generator of this type. This generator is a differentially wound, over-compounded machine whose electrical characteristics give a constant voltage of 30-40 volts over a speed range of 750 to 2,500 R. P. M. The armature is carried on S. K. F. self-aligning ball bearings which are automatically lubricated at all times. The brushes and commutator are made especially heavy to give extra long service without attention. The ends of the generator are completely inclosed from the weather and a small shaft fan affords ventilation through small shuttered windows in the end bells. The electrical rating of the generator is 1 KW, or 1⅓ H. P. The generator is geared direct to the windwheel, through a step-up gearing which gives 40 revolutions of the generator to one of the windwheel. The cast iron gears and phosphor bronze pinions have machine-cut teeth and are carried on S. A. E. alloy-steel shafts, which run on Hyatt Roller Bearings. The entire gear reduction runs in a bath of oil. The generator is bolted to the gear box casting in an accessible position and is easily removable, should the occasion ever arise.

From the generator the current is carried through a collector brush which allows the wheel to revolve about its axis. From this collector wires are carried down the tower and run to the house where the panel board and storage batteries are installed.

The windwheel is 14 feet in diameter, and has a maximum speed of about 60 R. P. M. It is held in the wind and controlled by a self-regulating rudder. These windwheels are the same as those which have been in constant service on power mills of the same make in the United States, Australia, South Africa and other countries for many years. A wheel of this size and type will develop as high as 3 H. P. in a 30 mile wind.

### Fifty Foot the Shortest Tower Recommended

In order to utilize wind power to the fullest advantage, the windwheel must be placed where it will receive every wind that blows. As mentioned previously, the slightest obstruction diverts a wind either upward or to one side and slight rises or dips in the land do this quite as effectively as houses and trees. Consequently the most effective use of the wind cannot be obtained unless the windwheel itself is placed a certain minimum distance above the ground. This the manufacturers of the plant in question have determined as 50 feet, so that the 14-foot wheel and its generating unit will not be supplied on any tower less than this height. In some locations it would undoubtedly be an advantage to use a higher tower, but for the average farm user, the 14-foot wheel on the 50-foot tower will provide all and more power than the battery can store. This battery consists of 16 cells of 240 ampere-hour capacity, or 7,680 watt hours, when the battery is used intermittently for light and power as is practically always the case with an installation of this kind.

### Automatic Switchboard

The switchboard is similar in most respects to those provided with an engine driven plant. It has connections and fuses for the charging line and the various service lines as well as an automatic cutout which places the bat-

tery in circuit with the generator whenever the wind reaches 6 miles per hour or over. This automatic cutout, or reverse current relay, is a newly patented type operating on a novel principle and is one of the important developments in connection with this plant. The board also carries the usual instruments consisting of a voltmeter and a double reading ammeter showing whether the battery is charging or being discharged. Another important feature of this switchboard is a double-pole, double-throw switch, enabling the owner of the plant to take advantage of very light winds as well as those above 10 or 15 miles per hour.

This switch is wired so that by throwing it to the left all the cells of the battery are placed in series with the generator to charge at 40 volts, while by throwing it to the right the battery is divided into two groups of eight cells, which are then charged in parallel at half the voltage. This switchboard is usually mounted in the kitchen of the farmhouse so that the operation of the plant is always under constant observation. To simplify the board, the series connection of the battery for charging at full voltage is marked "high winds" while the parallel charging side is marked "low winds." Except for reefing the wheel out of the wind when the battery is fully charged, the plant should need no attention on the part of the man in the family. This is an excellent selling argument for a dealer to use since so many farm light and power plants are really sold to the farmer's wife.

# Developing Small Water Powers

MILLIONS of dollars have been spent in the last few years in the development of great water powers, and every one realizes that these great improvements have added immensely to the wealth of the entire country. The average man, however, is apt to overlook the value of the small water power that is available right on his own land. This is partly due to the fact that with the old types of water wheels, these small powers were hardly worth developing. The old types of water wheels wasted so much water that only a small part of the stream was converted into energy, but the high efficiency of modern water wheels and the perfecting of the storage battery have made it possible to utilize much smaller powers than formerly.

The amount of water flowing in a stream is subject to remarkable variation. Only one who has observed very carefully and continuously, by actual measurement, the extremes of fluctuation to which a flowing stream is subject, is in a position fully to appreciate this. Some of the larger rivers are subject to such fluctuations of flow that the amount of water discharged during flood periods is several hundred times as much as the amount that flows in the extreme dry period. Also in many instances from one-half to three-fourths of the total runoff of the stream during the year occurs during a period of a few weeks in the spring months, when the accumulated snow and ice is melted and runs off in conjunction with the warm spring rains. Smaller streams for which records are available are subject to greater fluctuations per unit of tributary watershed area than are the larger streams. For most purposes power is required in about the same amount for all seasons of the year, while streams run off most of their waters in the spring. Therefore, if the power is required to be fairly constant, there are two important considerations:

First—Will the minimum flow of the stream in the driest season of a dry year, be sufficient to furnish the power required?

Second—If the minimum flow is not sufficient, what means are available for storing the surplus water?

*Text and illustrations courtesy of Fitz Water Wheel Co., Hanover, Pa.; W. J. Savage Co., Knoxville, Tenn.; S. Morgan Smith Co., York, Pa.; The Trump Co., Springfield, O.; The Pelton Water Wheel Co., San Francisco, Cal.; The Jas. Leffel & Co., Springfield, O.*

**Given a Steady Flow, a Brook Like This Is a Power Producer**

Streams having only one or two square miles of drainage frequently dry up entirely in the dry seasons. If a power development is proposed of such a character that some considerable sacrifice of power might be made in the dry seasons with no serious loss, most small streams may be developed to provide for as much as one-quarter to one-half of a cubic foot per second per square mile.

## How to Develop a Water Power

Water power can be developed wherever a stream of water falls over a ledge or runs swiftly over a series of shoals or rapids The amount of power which can be developed depends upon two factors, the volume of water which the stream flows per minute and the amount of fall which can be secured. Each of these factors is equally important. Each should be measured and the figures submitted to a competent engineer or an experienced manufacturer of water power equipment before any money is spent on the proposition. It requires about one cubic foot of water per second, falling through a height of ten feet, to make available one theoretical horsepower. To get the best results it is very important that the proper type of water wheel be used.

There are several types of waterwheels, the principal ones being known as "undershot," "pitchback," "overshot," "breastwheel," "turbine" and "impulse." The overshot wheel is a familiar type, as most early wheels were of this type and of home manufacture. This type of wheel depends entirely for its power upon the weight of the water which causes the wheel to revolve.

The undershot wheel is very similar in construction to the overshot type, but depends more for its power on the velocity of the flowing water which strikes the blades, or buckets, on the under side of the wheel.

The breastwheel is also similar in construction to overshot and undershot types. It depends for its power on a combination of the action of gravity and the impulse of the water striking the blades, or buckets. The water is fed into the wheel a little below the height of the axle and usually enters with considerable velocity, a part of which is transformed into useful work by the wheel.

The turbine is a type of wheel extensively used, but not for very small powers. It consists of a series of curve vanes, or runners, whose arrangement is similar to a screw. The action of the water flowing through these curved vanes causes the vanes and shaft to revolve, the vanes being solidly connected to the shaft, which may be either horizontal or vertical.

The working principle of an impulse waterwheel is the turning into useful work of the impulse due to the velocity of a jet of water issuing from a contracted orifice. This contraction of the stream causes the water to issue in a jet from the nozzle, striking the cups of the impulse wheel.

In general, the turbine type of wheel is best adapted to medium heads, or falls, and comparatively large volumes of water, the impulse wheel to the use of a comparatively high head, or fall, and a comparatively small amount of water. The overshot type requires very little water and utilizes heads down to four or five feet, the undershot being used on heads as low as three feet, both the under and overshot types being used where there is insufficient water for a turbine and not enough head for an impulse wheel. There are certain intermediate conditions for which the manufacturers of each type claim their wheel is best suited and a study of local conditions is always necessary to determine which type of wheel is best adapted.

**An illustration of how very small a stream may be put to use with the overshot type of wheel. In this case the water supply is very limited.**

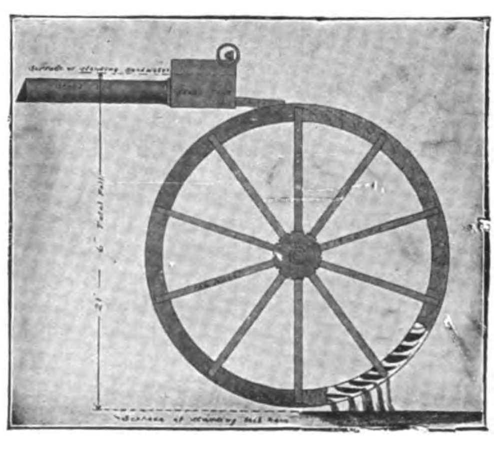
It must also be borne in mind that in each of the steps of transforming water power into electric current, transmitting the current over the wires, reconverting it into power, and in transferring this power from a motor to a power-operated machine, there are losses of energy. These losses vary considerably in different instances. Assuming, for illustration, that a water power, whose theoretical output is ten h.p., is required to drive a power machine at a distance, the efficiencies and losses will be somewhat as follows:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Waterwheel | efficiency | 80%, | Loss | 20%, | generates | 8.0 | horsepower. |
| Connections, | " | 95%, | " | 5%, | transfers | 7.6 | " |
| Dynamo, | " | 90%, | " | 10%, | generates | 6.8 | " |
| Transmission, | " | 90%, | " | 10%, | transmits | 6.2 | " |
| Motor, | " | 90%, | " | 10%, | develops | 5.5 | " |
| Connections, | " | 95%, | " | 5%, | delivers | 5.0 | " |

No one type of waterwheel will suit all conditions and not all of them are suitable for small installations. An engineer should be appealed to for unbiased advice on the subject of the proper wheel for the location.

A number of typical installations are referred to in the course of this article merely to give an idea of the class of streams, brooks and even springs which may be utilized for developing electric power, but the dealer who wishes to sell one of his customers a waterwheel installation and electrical equipment should realize that it is impossible to state definitely within the limits of an article of this kind just how much power can be developed from any given

**Illustrating the principles of operation of the overshot wheel and method of supplying it with water.**



water supply. No two powers are exactly alike and it is accordingly recommended that the dealer who finds that customers in his territory have available power sites should get in touch with some of the manufacturers of waterwheel equipment listed in this book. They will give him full information and assistance in showing how water power can be developed to the best advantage. The purpose of this article is of course chiefly to wake the dealer up to the possibility of adding to his profits by selling water driven equipment wherever he can. Whether it be driven by gasoline, wind or water, the dealer is in business to sell light and power plants as they build up the sales of appliances and accessories.

### Measuring the Fall

The first step in the development of a water power is to find out how much fall can be secured. If the fall is already concentrated at one point, in a cascade, or by means of a dam, it is a very simple matter to measure the VERTICAL distance from the top of the water at the crest of the cascade, down to the surface of the water at the foot of the fall. Do not make the common mistake of measuring down to the bed of the stream at the foot of the fall. Take your measurements only to the SURFACE of the water, in every case.

If the fall or "slope" of the stream is distributed over a series of rapids or little falls, it will be necessary to use a levelling instrument of some kind to determine the actual amount of fall which exists between the surface of the water at a point down stream below the rapids. A surveyor is often employed to run these levels, but any man with a fairly good eye, can get the approximate measurements by the aid of the ordinary carpenter's level.

### Where to Put the Dam

The total "fall" obtainable in the rapids must be concentrated as far as possible at one point, and the waterwheel should be installed at that point. In the case of a very small stream with a low fall it is usually desirable to build a small dam at the foot of the rapids, and back the water upstream over the rapids. The dam not only secures the fall necessary to run the waterwheel but it stores up (when the wheel is not in use) a reserve of water to be used during the full load period.

High dams are expensive to build, so if the fall is a considerable one, the dam should be placed near the upstream end of the rapids instead. The water can then be led through a pipe of the proper size to the place at the foot of the rapids where the wheel is to go. The same plan should be adopted even in the case of a very low fall when the banks of the stream are too low to permit the building of a dam high enough to secure the fall needed.

### If No Dam Is Used

If the natural flow of the stream is large enough to do the work desired, without depending upon the storage capacity of a dam or pond, then it is necessary to build a very low wing wall or diverting dam to throw a sufficient quantity of the water into a closed pipe at the head of the rapids. The pipe line may be laid from that point to the foot of the rapids running it along the surface of the ground or on the bed of the stream if desired. It need not be laid on a level but can follow the slope of the ground.

### Storage Battery Instead of Dam

In other cases, where the natural flow of the stream is very small, and yet it is not convenient to use a pond to store up water for power, the same effect can be secured by the use of a storage battery. The waterwheel can run all day long, generating all the power that the stream will afford, and using that power to charge the storage battery. The battery stores up electric current just as a pond stores up water. The waterwheel need never be stopped or started in this case. This plan is a very desirable one in many locations.

### Measuring Flow of Running Stream by Weir

The most accurate way of measuring the flow of a stream is by the weir dam method illustrated in an accompanying photograph. If the stream is not too large, take a board long enough and wide enough to form a dam across the stream. Cut a notch in this board, about two-thirds the width of the dam, and deep enough to allow all the water to pass through. Be careful to have the bottom of the notch exactly level so that the water will be of the same depth all the way across the notch. Bevel off the board on the down-stream side all around the notch, so that the sharp edge, as shown, will be on the up-stream side.

Drive a stake C, in the bed of the stream about four feet upstream from the weir board board A, so that the top of the stake will be just level with the bottom of the notch B, in the dam. See that the dam A, is made perfectly tight so that all the water must pass through the notch. Care should be taken to use a board wide enough to dam the water to a dead level before it begins to flow over the notch. After the water rises to its maximum height, D to E, over the notch, measure its depth on the stake, and also measure the width of the notch. The depth of the water should be measured on the stake which is level with the bottom of the notch, rather than on the notch itself, for the reason that the water falls over the dam in a curve so that it is impossible to obtain the true measurement right at the dam.

### Float Method Easier Way to Measure Stream

An easier method of measuring water is known as the Float Method. This is not as accurate as the weir method, but it is the most practical and convenient way of measuring larger streams. Select a place where the bed of the stream is smooth and comparatively uniform both as to width and depth. Throw into the middle of the stream some floating objects of sufficient weight to sink well into the water. Time the passage of these floats between certain fixed points, say 20 to 30 ft. apart. Note the time it takes the floats to travel this distance. Average the time of a dozen or more tests. Also note the width and depth of the stream at the point where the velocity was taken. The measurements of the depth and width should be taken at half a dozen points between the two points which were used in determining the velocity, so that average measurements can be secured. It is useless to attempt to measure the velocity of a stream in very windy weather as the wind will hinder the passage of the floats.

### The Steel Overshot Water Wheel

This type of wheel requires the minimum amount of water to run it and for that reason it is the wheel that is best suited to very small developments. In fact the efficiency and economy of water shown by the steel overshot type of wheel has made possible the development for electric purposes of many streams which would be entirely useless otherwise.

The overshot wheel derives its power directly from the force of gravity, the illustration showing the principle upon which it works. The weight of the water which is admitted to the buckets, loads one side of the wheel, causing it to revolve.

The water is applied to the wheel at a point close to the crown of the wheel, hence the name "overshot" in distinction from other types of gravity wheels, such as pitch-back, breast-wheels, and undershot-wheels.

The modern overshot wheel should not be classed with the old-style home made wood overshot wheels which still survive in many parts of the country. It differs from the old time overshot in design, construction and material, and very notably in performance. The buckets are not always straight as in an ordinary wheel but are given a peculiar curve which retains the maximum weight of water.

A water tight gate is a very necessary feature, as on small streams in very dry weather, it is essential to save all the water possible. A leaky gate


**Method of Measuring Flow of a Stream with a Weir**

will often allow enough water to escape at night to run a wheel for several hours a day.

## The Wheel for a Variable Stream

The object of all wheels is to utilize the weight of the falling water and to develop power thereby. The overshot wheel does this directly while turbines and other types develop power indirectly by reaction or impulse caused by pressure. To give good results they must be geared to run at certain speeds and pressures and using a certain amount of water. In most small streams these conditions are constantly changing, causing a loss of efficiency. Since the overshot wheel depends mainly upon the weight of the water, it can be run fast or slow, with high head or low head, at full gate or fractional gate, with equally high efficiency, developing power in proportion to the amount of water used. The size of an overshot wheel depends largely upon the situation, but the diameter is usually made about two feet less than the total available head. The width is determined by the flow of water and the amount of power to be developed.

## Cost of Water Power Plants

Water power is a gift of nature. All the water wheel can do is to make use of the force which already exists in the stream. You can't buy a water wheel first and then find a power to suit it.

Many inquirers ask "What does a 5-h.p. water wheel cost?" There is no way of telling unless something definite is known about the location. Some water powers are much more expensive to develop than others. A 5-h.p. wheel of certain proportions may cost four times as much as another of the same power but different proportions. The proportions are fixed by the conditions of the stream. To prevent expensive mistakes, manufacturers usually ask for the information required by the typical data sheet shown at the end of the article so that they can recommend the right wheel for the requirements.

## Some Typical Small Installations

In order that the dealer may form some idea of the possibilities of streams in his locality a few installations are described which may answer as a basis of comparison with his own conditions.

Brook sufficient in ordinary times to flow 3-inch deep through a notch in a weir board 10-inch wide. With this small stream, house and garage are lighted and many electrical devices operated. An overshot wheel 10 ft. diameter by 1 ft. face drives a small dynamo charging a storage battery. No dam is required for the water is piped direct to the top of the wheel

and current taken from the battery. Eight to ten lamps at a time are burned for five to six hours a day, or a larger number for a shorter period of time. When the stream runs higher as it does in spring and winter, more power is available.

Another installation using a storage battery has only 6 ft. fall but has a stream of water which will flow 3" deep through a notch in a weir board 24" wide. This uses an overshot wheel 4½ ft. diameter, but of wider face, to drive a 32-volt dynamo charging a storage battery. In spite of the lower fall about twelve lamps may be burned for six hours a day because there is more water to drive the wheel.

### Taking Current Direct from Dynamo

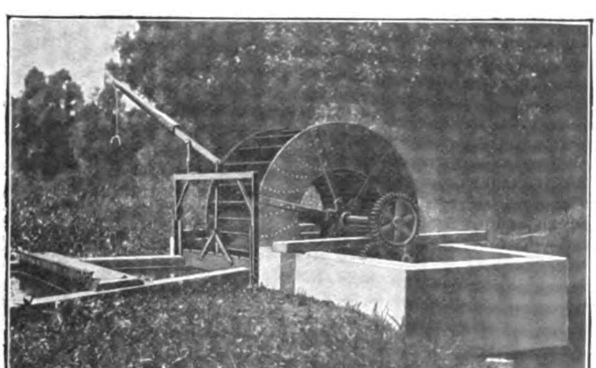
In this installation a very small stream is used without a storage battery. A 6 ft. diameter by 2 ft. face steel overshot wheel driving a ⅞ kw. generator for lighting. With gate of wheel raised one-half inch (12" head of water standing in box back of gate) six 20 c. p. tungsten lamps are fed direct from the dynamo, which generates current at 110 volts. Line is No. 8 copper wire, running a distance of 600 ft. to the house.

On a small stream like the above, the use of a storage battery is usually recommended. The water wheel can be run 24 hours a day, charging the battery all the time. In this case, of course, a considerably larger number of lamps can be used during the few hours when light is most needed. During the hours when only a few lights are needed the current will be accumulating in the battery just as the water does back of a dam.

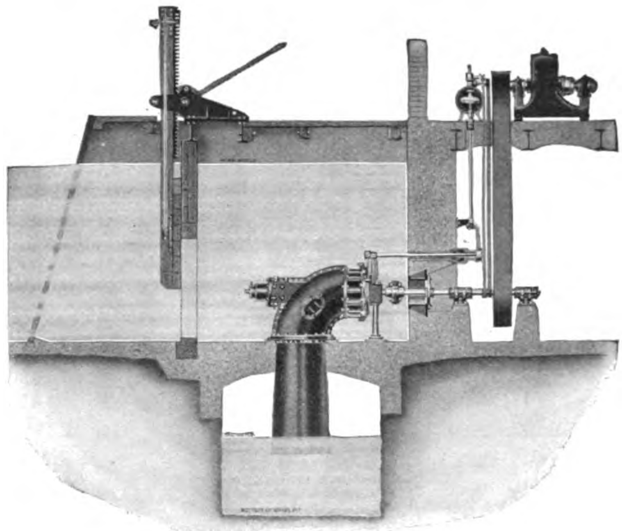
On another installation there is a lively little brook 2 ft. wide by 6 inch deep. Float tests showed that it took twelve seconds for a weighted block of wood to travel 20 ft. down stream. Running levels showed that 13 ft. fall in 480 ft. length of the brook could be secured. The customer was advised to build a wall across the brook about 4 ft. high near the head of the rapids, so as to dam the water up enough to take up part of the fall; then to lay 10-inch riveted steel pipe from the dam to a point down towards the foot of the rapids, where he could install a 10 ft. diameter wheel.

### How the Fall Was Taken Up

In order to save as much pipe as possible, the dam was built across the stream at a point 230 ft. below the rapids, taking up all the fall which existed in that 230 ft. by backing the water up over the rapids. The bed of the stream sloped very rapidly for the first 80 ft. down stream from the dam and then more gradually from that point on. The water was led from the dam through a riveted steel pipe for the distance of about 80 ft., thus taking up 5 ft. more fall below the dam. The wheel was located at this point, a little off to one side of the creek to protect it from floods. The remaining four feet fall was taken up by digging a ditch or "tail-race" with a slant of about four inches to 100 ft. parallel to the general direction of the bed of the stream, to



**The "Breast" Wheel is a type that may be used where a very low head is available. It will develop power on as little as three feet fall.**



**Typical installation of small turbine with belt drive to a horizontally mounted generator.**

a point down stream where the "tail-race" could join the main stream again on a level.

### The Work This Outfit Is Doing

The plant consists of a 10 ft. diameter by 1½ ft. face steel overshot wheel and a 3 kw. G. E. D. C. dynamo. The customer, with the aid of two others, made the installation himself, doing all the work of building the dam, and installing the plant. With this outfit he is lighting 140 tungsten lamps at a time, furnishing light for two farms in addition to his own. The starting and stopping of the wheel is controlled by a wire cable from the house distant 600 ft. Beside light, a milking machine, cut-off saw, washing machine, vacuum cleaner, churn and numerous small electric cooking utensils are operated. A portable motor saves money and time in spraying, etc. The entire plant costs nothing to run except a little oil occasionally, and perhaps a few fuses.

### If No Dam Had Been Used

This installation at considerable length because it affords a good example of the steps taken in the development of the average water power for farm use. In this case, the storage capacity of a dam is utilized to run a 3 kw. generator without a battery.

If it had been inconvenient to build the dam enough power would have been secured from the natural flow of the stream to furnish all the light needed. In that case, the flow of the creek would have been diverted into a smaller diameter pipe and carried down to the wheel as described. A narrower face wheel would have been furnished with a 1 kw. dynamo and would have generated current enough for about forty lamps, or more than enough for ordinary requirements. But it would not provide power to run electric motors exceeding one h.p. A plant operated by the natural flow of the stream would be less expensive to install.

### What Could Be Done with a Lower Fall

If this stream (2 ft. wide by ½ ft. deep, flowing 20 ft. in twelve seconds) had afforded only 7 ft. instead of 13 ft. fall, a 5 ft. diameter wheel could have been used. With a wheel of this size, using the natural flow of the stream, about fifteen to twenty lamps could be supplied with current.

With the aid of a dam, however, three times as many lamps could be burned for eight hours a day, provided the dam was of sufficient capacity to store the flow during the remaining sixteen hours of each day. The cost of the outfit needed for this fall would depend upon the capacity desired.

If a fall of only 5 ft. had been obtainable, this power could still be developed in a satisfactory manner by using a pitchback type wheel but the work done would be in proportion to the fall used.

So many different conditions exist and so many different combinations of circumstances are possible that it is always advisable to ask the advice of an engineer in a matter of this kind.

### Power Site Located ½ Mile from the House

At Clinton, N. Y., there is a very interesting installation. The water wheel is located more than half a mile from the house and barns and runs all the time, the surplus power being consumed by electric heaters in the house.

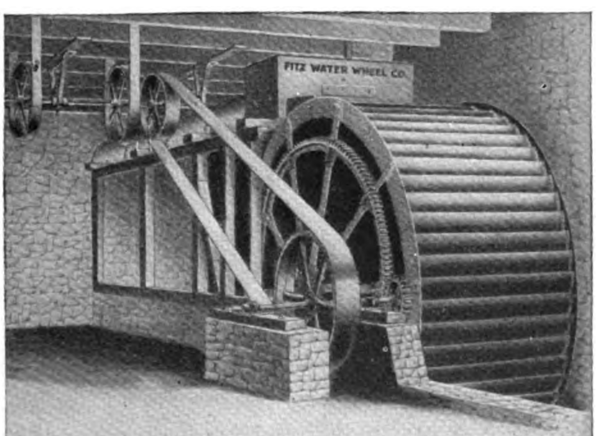
The first attempts to develop this water power were not successful, the common mistake of putting in a turbine on a stream too small for a wheel of that type being made. A turbine will give splendid results when installed in a suitable location but many turbines have been installed in places where they proved disappointing. The manufacturer who furnished the original equipment was compelled to take the first wheel back and furnish a smaller one. The second wheel was a failure too, for it took so much water that it emptied the pond in three hours. But the owner was not easily discouraged.

A 16 ft. diameter by 2½ ft. face overshot wheel was installed in place of the turbine, as plenty of power to drive motors at the barn was needed. There has never been any trouble about scarcity of water since the overshot wheel was put in, the only difficulty being in taking care of the power not needed. Due to the distance it is not practical to stop the wheel whenever power is not needed. This was overcome by installing electric heaters consuming a great deal of current. Except when running a silo cutter, or other seldom used machines, the water wheel gate is kept set at the same opening, viz.: ⅞ inch high by 24 inch wide, and the wheel runs all the time, night and day. The head of water back of the gate is 23 inch, so discharge is about as much as would flow through a notch 4 inch deep by 20 inch wide in a weir.

This supplies from thirty to forty lamps at the house, half a mile away. Ordinarily not more than twenty lamps at a time are used. As a battery of lamps is switched off one of the heaters is automatically switched on to consume the extra current. In this way there is ample current available at all times to run various convenient electrical devices in addition to ordinary lighting.

### Pitchback and Undershot Water Wheels

Most of this article is devoted to a description of the overshot water wheel because this type is suited to the majority of very small isolated electric plants. For many locations, however, this type of wheel would not do at all.



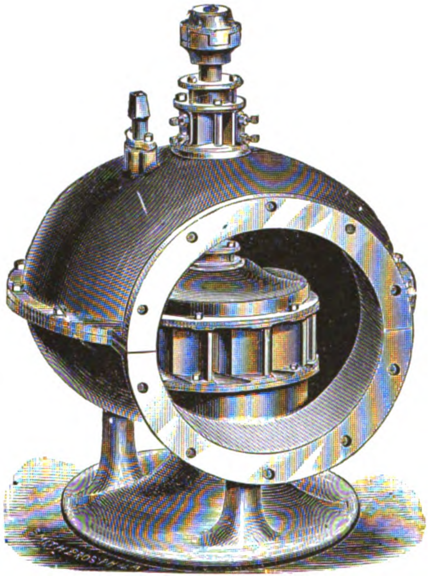

**An overshot wheel of this size with an ample water supply would produce enough current to run a large farm or light a village**

For falls which are too low for an overshot wheel, the pitchback wheel is often used, the operation of which is shown by the accompanying illustration.

For exceedingly low heads, say anything under 3 ft. head, the undershot is the only type of wheel which can be used. It requires a great deal more water to run it than an overshot or a breast wheel but it enables many streams to be used which would be worthless for other kinds of water wheels. This type of wheel is also used for higher heads under certain circumstances.

### Turbine Wheels

The turbine is too well known to require extended description. It will give splendid service wherever there is water enough to run it. Its efficiency is not as high as that of the steel overshot type and it is not adapted for use on such small streams, but where circumstances will permit its use it is much the cheapest type of equipment to buy.



**Self-contained Turbine Unit, mounted complete in a cast iron housing. This type is the simplest to install in small power developments in which a turbine can be used.**

Turbines are furnished either for mounting in wood or concrete penstocks or mounted in an iron or steel case, as shown in the accompanying illustrations. Turbines having cases equipped with a flange ready for bolting to the end of the pipe line or flume, afford the simplest way to install a turbine, and this type is recommended for small powers. The wheels are mounted vertically or horizontally, in water-tight iron or steel cases, affording a strong and compact power unit. The use of the case eliminates any leakage which may occur in the use of a wood or concrete penstock, that is usually much more expensive to build.

The drive from the turbine is secured in a simple manner. Where a vertical type is used a bevel gear is mounted on top of the vertical shaft, driving a pinion keyed to a horizontal shaft. On this horizontal shaft is mounted a pulley from which the generator or other machinery may be driven.

Instead of the bevel gear drive, a pulley may be mounted on the vertical shaft, driving to the generator or other machinery by means of a quarter twist belt.

The horizontal turbine furnishes a simpler drive. The main shaft of the turbine is horizontal and the main driving pulley is mounted on it, the generator being driven directly from the pulley.

The table (page 63) gives approximate size of small turbines of the amount of water required for operation, the speed, and the power developed at full gate under heads of from four to eighteen feet. These sizes will cover the ordinary farm requirements ranging from 1½ to 13½ h.p.

## Impulse Type Water Wheels

In addition to the various types already described, there is also the impulse or Pelton type of water wheel, consisting of a rotor carrying specially designed buckets on its circumference. The water is supplied to the wheel through a special form of nozzle. In the smaller sizes particularly, the Pelton is more of a water motor than a water wheel as the latter term is commonly understood.

The water supply for this type may be obtained from one or more of many different sources. Independent pipe lines, connections to water works mains, artesian wells or pump pressure lines have been extensively used. Other sources of water supply are creeks and springs, from which sufficient water can be piped to a lower elevation to provide the necessary head or pressure. A small amount of water under a comparatively low head will operate the smaller units satisfactorily.

Each one of the above sources has been utilized to provide water for Pelton wheels used in driving electric generators.

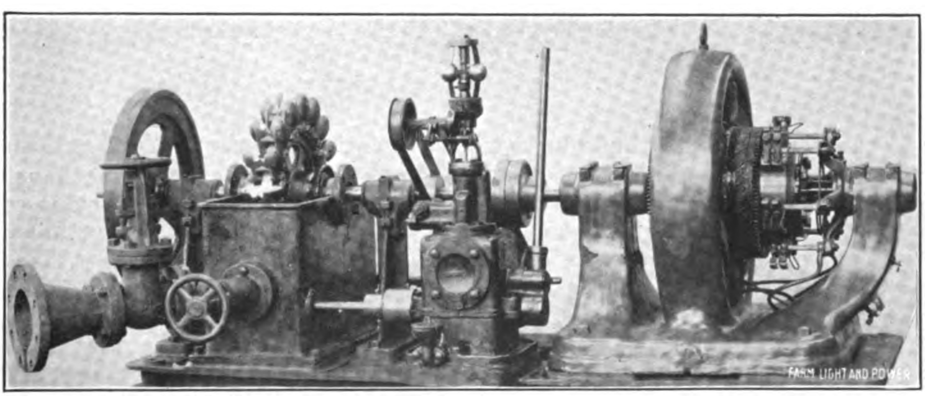
When the source of supply is an artesian well, a test should be conducted to ascertain the effective pressure of the well when the water is discharging through a circular orifice of known diameter. A simple test-rig for the purpose consists of an accurate indicating pressure gage located about 3 feet from the point of discharge, where the wheel is to be placed, a gate valve and several pipe fittings and nipples.

The procedure to be followed is to first note the pressure on the well when capped (i. e., with no water flowing). This is termed "standing or static pressure." Then allow the water to discharge through a pipe nipple or bushing and note the "running pressure" as indicated by the gage. Several experiments should be conducted by varying the diameter of the discharge and noting the gage readings for each size. As the diameter of the discharge orifice is increased, the gage will show a greater reduction in running pressure. The diameters of the nipples and the accompanying pressure should be recorded.

When the source of supply is a stream or similar body of running water, the data desired are best obtained by the use of a weir as already described.

## Water Storage

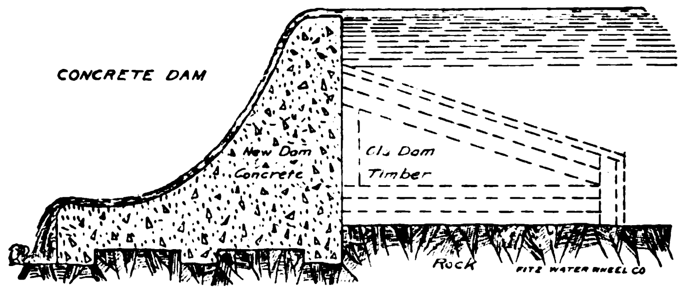
While the building of a dam of sufficient size for the ordinary farm water power should not be a difficult undertaking, many of us are at a loss to know just where to begin, what material to use, or what shape to give the structure. For the benefit of those who are considering the construction of a storage pond, the following cuts or diagrams are added, giving a general idea of



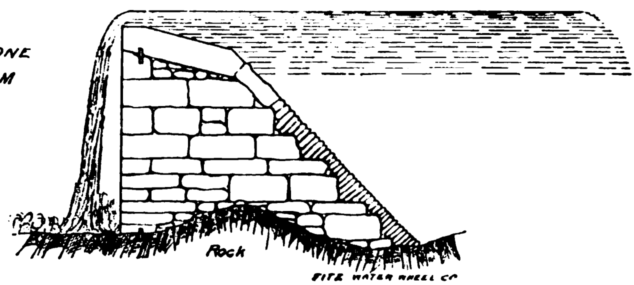

**One Type of Pelton Wheel or "Water Motor" Used on Small Power Installations**

this class of work, and showing in general way how these dams may be built. In their construction, either wood, stone or concrete may be used, whichever happens to be on hand, or most easily obtained.

**One way of rebuilding an old timber dam with a concrete face. On a new dam the rear face would slope as shown by the timbers.**




To anyone familiar with the handling of concrete, this makes a very neat and permanent means of obtaining water storage. It is possibly the best and most shapely structure which can be used. The old wood dam need not be removed.

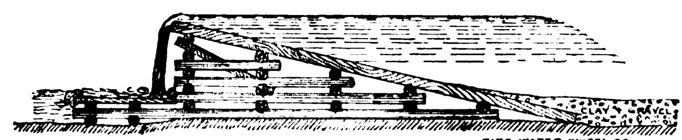



**Many farmers have more stone than they know what to do with. A simple and enduring form of construction.**

A very good type of dam made from stone. The outer layers should be bound with concrete or concrete mortar to render it perfectly tight.

In sections of the country where timber is easily obtained, this is a very inexpensive dam to build. Easy to construct and very satisfactory where only a small dam is required.

**One of the easiest forms of dams to erect, where only a low head is available.**

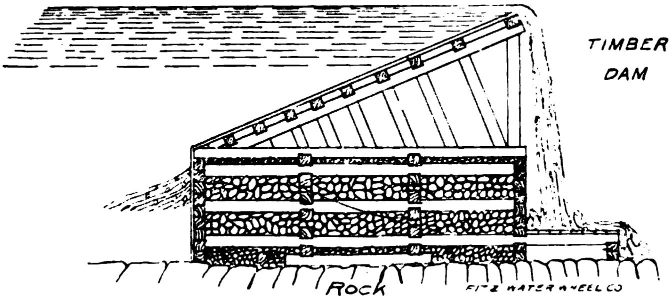



LOG DAM

Another method of building a wood dam where greater height is desired.

Owing to the great variety of conditions which enter into the development of a water power, it is impossible to publish a list of the various combinations of wheels and dynamos which might be used. Each plant must be built up to meet the conditions under which it is compelled to work.

The wheel which is installed, the kind of wheel as well as its size, is determined by taking into consideration the amount of fall which can be developed most economically, as well as the flow of water available. The question of a dam must also be considered, whether it is necessary or even possible if desired. Then, too, if the power is a very small one, the proper storage battery must be selected, all tending to cause a change in the outfit to be used.

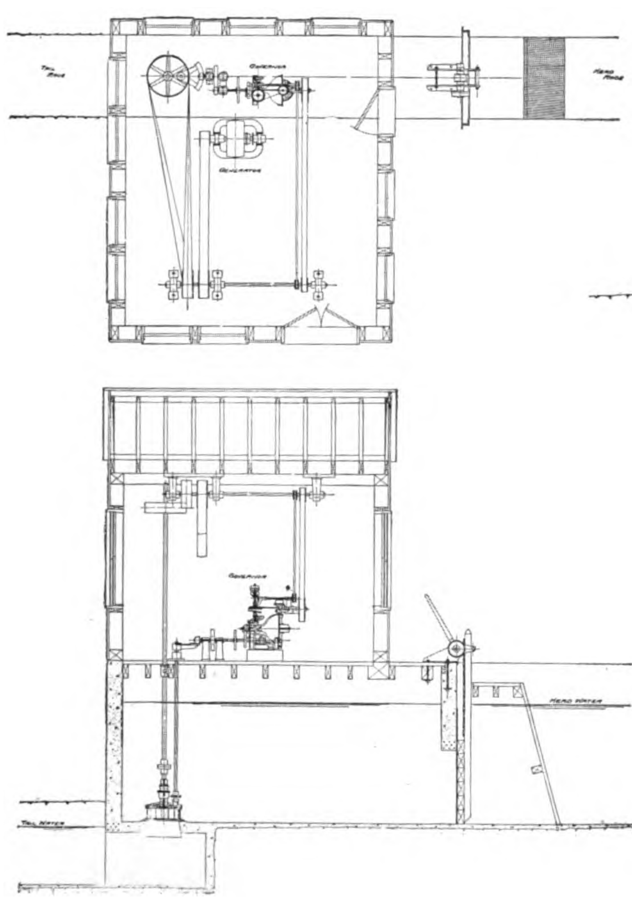


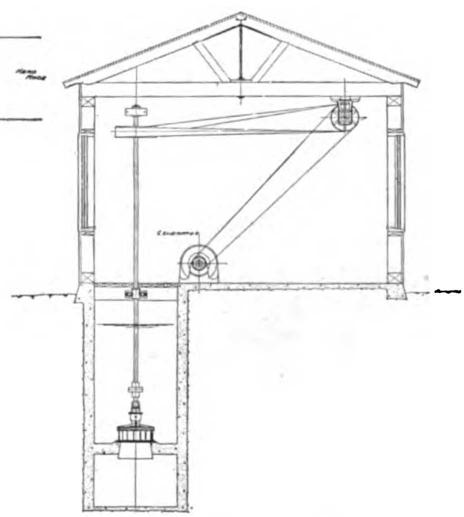

**Crib and timber construction — an easily built type for a higher head than the log dam.**

### Types of Generators

Care should be exercised in the selection of the generator, for next to the water wheel it is the most important part of the power equipment. A slow speed generator should by all means be chosen, for by the use of a machine of this kind the amount of gearing can be greatly reduced, a more direct drive secured, and the cost of the equipment kept to a minimum. The generator is subjected to severe and steady service and longer wear can naturally be secured from slow running machine:

In many small water power installations, the current is drawn directly from the generator without being stored in batteries. Variations in the intensity of the light being taken care of by the compound winding of the generator, permitting the voltage to be adjusted to exactly the values required for circuit conditions.





Typical methods of installing vertical turbines to drive horizontal generators. Left—Plan and elevation of governed turbine. Above — Simpler installation without governor.

### Velocity of Water

Velocity of water in feet per second and cubic feet of water per minute to develop one horse-power at 80 per cent. efficiency, under heads from 1 to 50 feet.

| Head | Velocity | Cubic Feet | Head | Velocity | Cubic Feet |
|---|---|---|---|---|---|
| 1 | 8 | 661 | 26 | 40 | 25 |
| 2 | 11 | 330 | 27 | 41 | 24 |
| 3 | 13 | 220 | 28 | 42 | 23 |
| 4 | 16 | 165 | 29 | 43 | 22 |
| 5 | 17 | 132 | 30 | 43 | 22 |
| 6 | 19 | 110 | 31 | 44 | 21 |
| 7 | 21 | 94 | 32 | 45 | 20 |
| 8 | 22 | 82 | 33 | 46 | 20 |
| 9 | 24 | 73 | 34 | 46 | 19 |
| 10 | 25 | 66 | 35 | 47 | 18 |
| 11 | 26 | 60 | 36 | 48 | 18 |
| 12 | 27 | 55 | 37 | 48 | 17 |
| 13 | 28 | 50 | 38 | 49 | 17 |
| 14 | 30 | 47 | 39 | 50 | 16 |
| 15 | 31 | 44 | 40 | 50 | 16 |
| 16 | 32 | 41 | 41 | 51 | 16 |
| 17 | 33 | 38 | 42 | 51 | 15 |
| 18 | 34 | 36 | 43 | 52 | 15 |
| 19 | 34 | 34 | 44 | 53 | 15 |
| 20 | 35 | 33 | 45 | 53 | 14 |
| 21 | 36 | 31 | 46 | 54 | 14 |
| 22 | 37 | 30 | 47 | 54 | 14 |
| 23 | 38 | 28 | 48 | 55 | 13 |
| 24 | 39 | 27 | 49 | 56 | 13 |
| 25 | 40 | 26 | 50 | 56 | 13 |

Note—Exact figures for both velocity and volume (cu. ft.) are slightly greater but fractions are omitted to simplify the table.

### Table for Weir Measurement

Giving cubic feet of water per minute, that will flow over a weir 1 inch long and from ⅛ to 20⅞ inches deep.

| Depth | Inches | ⅛ | ¼ | ⅜ | ½ | ⅝ | ¾ | ⅞ |
|---|---|---|---|---|---|---|---|---|
| **0** | .00 | .01 | .05 | .09 | .14 | .19 | .26 | .32 |
| **1** | .40 | .47 | .55 | .64 | .73 | .82 | .92 | 1.02 |
| **2** | 1.13 | 1.23 | 1.35 | 1.46 | 1.58 | 1.70 | 1.82 | 1.95 |
| **3** | 2.07 | 2.21 | 2.34 | 2.48 | 2.61 | 2.76 | 2.90 | 3.05 |
| **4** | 3.20 | 3.35 | 3.50 | 3.66 | 3.81 | 3.97 | 4.14 | 4.30 |
| **5** | 4.47 | 4.64 | 4.81 | 4.98 | 5.15 | 5.33 | 5.51 | 5.69 |
| **6** | 5.87 | 6.06 | 6.25 | 6.44 | 6.62 | 6.82 | 7.01 | 7.21 |
| **7** | 7.40 | 7.60 | 7.80 | 8.01 | 8.21 | 8.42 | 8.63 | 8.83 |
| **8** | 9.05 | 9.26 | 9.47 | 9.69 | 9.91 | 10.13 | 10.35 | 10.57 |
| **9** | 10.80 | 11.02 | 11.25 | 11.48 | 11.71 | 11.94 | 12.17 | 12.41 |
| **10** | 12.64 | 12.88 | 13.12 | 13.36 | 13.60 | 13.85 | 14.09 | 14.34 |
| **11** | 14.59 | 14.84 | 15.09 | 15.34 | 15.59 | 15.85 | 16.11 | 16.36 |
| **12** | 16.62 | 16.88 | 17.15 | 17.41 | 17.67 | 17.94 | 18.21 | 18.47 |
| **13** | 18.74 | 19.01 | 19.29 | 19.56 | 19.84 | 20.11 | 20.39 | 20.67 |
| **14** | 20.95 | 21.23 | 21.51 | 21.80 | 22.08 | 22.37 | 22.65 | 22.94 |
| **15** | 23.23 | 23.52 | 23.82 | 24.11 | 24.40 | 24.70 | 25.00 | 25.30 |
| **16** | 25.60 | 25.90 | 26.20 | 26.50 | 26.80 | 27.11 | 27.42 | 27.72 |
| **17** | 28.03 | 28.34 | 28.65 | 28.97 | 29.28 | 29.59 | 29.91 | 30.22 |
| **18** | 30.54 | 30.86 | 31.18 | 31.50 | 31.82 | 32.15 | 32.47 | 32.80 |
| **19** | 33.12 | 33.45 | 33.78 | 34.11 | 34.44 | 34.77 | 35.10 | 35.44 |
| **20** | 35.77 | 36.11 | 36.45 | 36.78 | 37.12 | 37.46 | 37.80 | 38.15 |

Example Showing Application of the Weir Table: Suppose weir to be 72 inches long, and depth over stake to be 11⅝ inches. Follow down the left-hand column of the figures in the table until you come to 11 inches. Then run across the table on a line with the 11, until under ⅝ on top line, you will find 15.85. This multiplied by 72, the length of weir, gives 1141.2, the number of cubic feet of water passing per minute.

### Small Turbines and Water Required

The following table lists small turbines with the amount of water required for operation, the speed, and the power developed at full gate under heads of from four to seventeen feet. These sizes cover the ordinary farm requirements.

| Head in feet. | Size of Wheel | | | | | |
|---|---|---|---|---|---|---|
| | 9" | 10½" | 12" | 13½" | 15" | Diameter of Wheel |
| | 89 | 121 | 159 | 201 | 247 | Cubic feet |
| 4 | .55 | .75 | 1.00 | 1.25 | 1.53 | Horsepower |
| | 270 | 232 | 202 | 180 | 162 | Revolutions |
| | 100 | 135 | 177 | 225 | 277 | Cubic feet |
| 5 | .77 | 1.05 | 1.40 | 1.74 | 2.15 | Horsepower |
| | 302 | 258 | 226 | 201 | 181 | Revolutions |
| | 109 | 149 | 194 | 246 | 303 | Cubic feet |
| 6 | 1.02 | 1.36 | 1.81 | 2.28 | 2.82 | Horsepower |
| | 330 | 284 | 248 | 220 | 198 | Revolutions |
| | 118 | 161 | 210 | 265 | 328 | Cubic feet |
| 7 | 1.29 | 1.75 | 2.29 | 2.88 | 3.57 | Horsepower |
| | 358 | 306 | 268 | 236 | 214 | Revolutions |
| | 126 | 171 | 225 | 283 | 351 | Cubic feet |
| 8 | 1.57 | 2.13 | 2.79 | 3.51 | 4.37 | Horsepower |
| | 382 | 327 | 286 | 255 | 229 | Revolutions |
| | 134 | 182 | 238 | 300 | 372 | Cubic feet |
| 9 | 1.87 | 2.54 | 3.33 | 4.20 | 5.21 | Horsepower |
| | 404 | 348 | 304 | 270 | 243 | Revolutions |
| | 141 | 192 | 250 | 316 | 391 | Cubic feet |
| 10 | 2.18 | 2.98 | 3.89 | 4.93 | 6.07 | Horsepower |
| | 426 | 366 | 320 | 285 | 256 | Revolutions |
| | 148 | 201 | 262 | 333 | 411 | Cubic feet |
| 11 | 2.53 | 3.42 | 4.47 | 5.67 | 7.01 | Horsepower |
| | 448 | 384 | 336 | 298 | 269 | Revolutions |
| | 154 | 210 | 274 | 348 | 429 | Cubic feet |
| 12 | 2.88 | 3.90 | 5.10 | 6.47 | 7.98 | Horsepower |
| | 468 | 401 | 351 | 312 | 281 | Revolutions |
| | 160 | 219 | 286 | 363 | 447 | Cubic feet |
| 13 | 3.24 | 4.41 | 5.77 | 7.32 | 9.02 | Horsepower |
| | 487 | 417 | 365 | 325 | 292 | Revolutions |
| | 166 | 228 | 297 | 376 | 465 | Cubic feet |
| 14 | 3.61 | 4.93 | 6.45 | 8.18 | 10.08 | Horsepower |
| | 505 | 433 | 379 | 337 | 303 | Revolutions |
| | 172 | 236 | 308 | 389 | 481 | Cubic feet |
| 15 | 4.00 | 5.47 | 7.17 | 9.03 | 11.16 | Horsepower |
| | 523 | 448 | 392 | 349 | 314 | Revolutions |
| | 178 | 244 | 318 | 402 | 497 | Cubic feet |
| 16 | 4.41 | 6.03 | 7.89 | 9.97 | 12.30 | Horsepower |
| | 540 | 463 | 405 | 360 | 324 | Revolutions |
| | 184 | 251 | 327 | 414 | 512 | Cubic feet |
| 17 | 4.84 | 6.60 | 8.61 | 10.91 | 13.48 | Horsepower |
| | 557 | 477 | 417 | 371 | 334 | Revolutions |

**Typical Information Sheet Used By Manufacturers of Water Wheels to Obtain Data for Installations**

What is the flow of the stream? If measured by weir dam method give width of notch and depth of water in inches ...............................
If measured by float method, give average width of stream..............
average depth................ How long (in seconds) does it take to float a chip 20 feet? .......................................................
How much fall can you get? ..........................................
In what distance is this fall obtained? ....................................
Is there a dam on the place?............ If so, how high?..................
How wide?......... How far up stream does it back the water? ............
Is the entire fall taken up by the dam or can additional fall be obtained below the dam? ..........................................................-
How many lights are to be used at one time? .........Give the smallest number and wattage that would be satisfactory................. Give the largest number desired.............. Is electric power to be used for other purposes than for lighting?................. What kind of machinery to be driven and the power required?.........................................
How far from the proposed water wheel site would it be to the house?.......
To the barn?............. About how much further to the most distant point where power would be used?................................ Is there a dynamo or storage battery in use on the place now?......................
If so, what size and what voltage?......................................

Give a rough sketch on the back of this sheet, showing the location of the stream, dam, water wheel, buildings, etc., giving measurements when possible ..............................................................

Give any other information which you think may be useful.

# Light and Power for Villages and Communities

EVERY village, town or community in the United States not served by electric power lines from a central station is a potential prospect for the sale of an isolated electric light and power plant. According to the latest figures available, there are 125,929 villages and towns in this country having a population of less than 1,000 inhabitants. There are about 9,800 of such towns in the State of Pennsylvania alone.

Of this large number of small towns it is estimated that approximately 80 per cent. are entirely without electric service of any kind; many of them are without even remote prospects of being served by central stations.

These people want electric light and other electrical necessities for the modern home, such as vacuum cleaners, electric irons, washing machines, refrigerating machines, motors for pumps and for various other power purposes. They are willing to pay a reasonable price for electric service.

It is practical for these villages and towns to have electric service at a reasonable rate, without prohibitive initial or maintenance cost, and without any delay.

Dealers in these outlying districts cannot afford to overlook the possibilities of such a market. The sale and installation of a reliable plant in such a community will net the dealer immediate returns and also opens up a continuous market for electrical equipment and supplies.

### Current at Standard Voltage

The most practical current for small towns and villages is 110 volts D. C. This allows the use of standard electrical equipment and supplies. Standard voltage apparatus, such as flat irons, toasters, heaters, washing machines, ironers, fans, vacuum cleaners and the like, is manufactured on a quantity production basis so that the interests of customers are best served by making it possible for them to use standard voltage equipment.

Again by the use of standard 110 volts, approved fixtures, switches, sockets and lamps are readily obtainable, and when installed in accordance with the regulations of the Fire Underwriters, fire hazard is eliminated.

The initial cost of wiring for transmission is greatly reduced by using 110 volts instead of a lower voltage, since a smaller wire will carry the same amount of power or light over a given distance with no greater drop in voltage. It is also practical at this voltage to extend wiring a greater distance from the generator and proportion it for minimum transmission losses.

### Batteries Needed to Give 24-Hour Service

While these generator sets may be operated either with or without storage batteries, it has been found quite essential for small town and community uses to provide the installation with a storage battery of suitable capacity. Electric current is then available twenty-four hours per day, regardless of whether the generator set is in operation or not.

A 5 K.W. set is well suited for installations at the smaller centers of population, where a dozen or less buildings are to be lighted, and where electric motor requirements do not exceed a total of 5 horse power at any time. A set of this capacity will handle 200 25-watt lamps at full load or 250 of the same lamps (25 per cent. overload) for two hours at a time. Or it will handle 100 25-watt lamps and 3 H.P. of motor load at the same time.

In one instance, the owner purchased one of these sets to light his store, hotel and moving picture house. In this case the storage battery load is small, since the generator set is always in operation when the moving picture machine is in use. The picture machine is a Powers Arc Light type and the combined load, including hotel and store lights and the picture machine, often reaches 60 amperes, or about 30 per cent. overload.

*Contributed by H. W. Cheney, engineer, electrical department, Allis-Chalmers Mfg. Co.*

In another case, a 5 K.W. set is installed in the basement of a schoolhouse in Michigan. Current is available for lighting the buildings in the immediate neighborhood, including a large church and for a 2 H. P. motor operating a pipe organ in the church.

One of the many 5 K.W. plants in use is installed in a hatchery in North Carolina. Part of the equipment is a 10,000-egg Buckeye incubator, in which is installed three ventilating fans operating continuously. In this kind of service dependability is of prime importance, since failure of power would be sure to entail considerable loss.

### Form a Company to Buy and Operate Plant

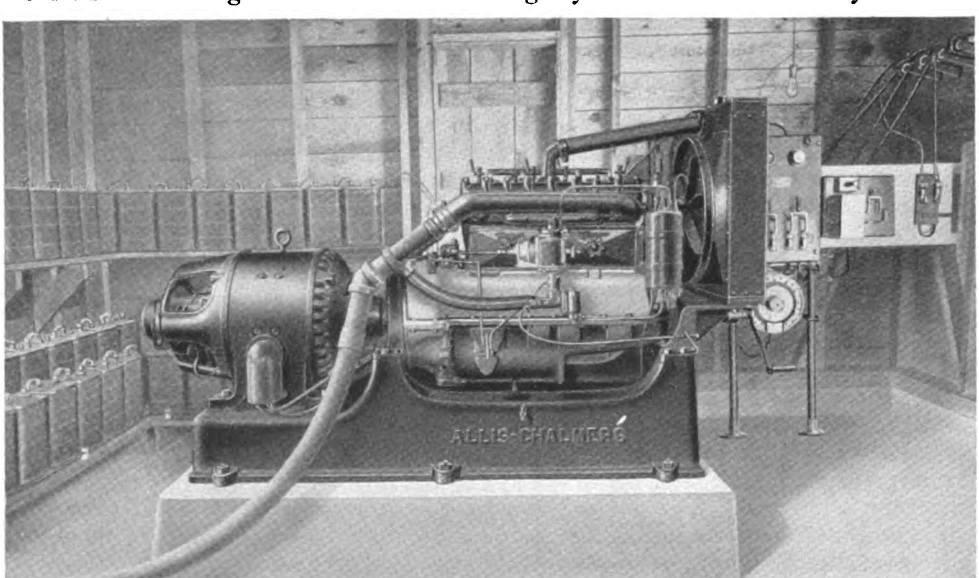
A 15-kilowatt, 110-volt direct current plant is well suited for power and light in villages and towns. An installation in North Carolina was purchased by a group of men consisting of the mayor and nine other citizens, who formed a small company. The total equipment, including batteries, street lines, etc., cost them about $5,000.00. Current is supplied to four stores and to the residences of the town. They are marketing electrical output at the rate of 8 KWH. for $2.50 and 30 cents for each KWH. over. Cost of operator, $30.00 per month. This plant showed an operating profit shortly after installation, when only one-fourth of the plant's output was being marketed. The citizens of the town are well satisfied with the electric service they are getting.

The 15-K. W. plant will handle 600 25-watt lights when operating at full load, or 750 of the same lights for two hours (25 per cent. overload). It will handle an electric motor load of 10 H. P. and at the same time carry 200 25-watt lights.

As a general rule, a 15-K. W. plant will supply enough power and light for approximately 50 average village buildings, including residences, stores, garage, church and movie theatre, and there is a great advantage in having one 15-K. W. plant for a community instead of each householder having his own small plant.

### Layout of Village Should Be Studied

Most villages and towns are not laid out according to any particular plan. The location of residences, churches and other buildings oftentimes appears to be determined largely by accident rather than by choice, so that it is advisable to give the matter of wiring layout considerable study in order




**Allis-Chalmers 15-Kilowatt Generator Set Village Lighting Plant, Battleboro, N. C.**

to reduce the initial wiring cost to a minimum and to keep voltage drop and line losses within reasonable limits.

The plan of a typical village shown on page 71 illustrates the point above mentioned, and which will serve as the basis for an estimate of what may be expected by way of returns on the investment, provided the citizens get together and form a small company for the purchase and installation of a light and power plant.

Each town presents a different problem, but a suggested method of procedure in getting up an estimate for any proposition for small town lighting by means of a gasoline engine driven generator is given here.

In making an estimate of this kind there are many factors governed by local conditions entering into the problem. The figures given herein are only approximate, but will serve as a guide in preparing other estimates.

**Estimated Cost of Typical Installation**

It is necessary to make certain assumptions at the outset. In this case these assumptions are based upon actual results obtained on plants which have been in service for some time and represent, as far as data are obtainable, approximately average conditions. For the purposes of this estimate the following is assumed:

1. Equipment to consist of 15-K. W. 125-volt gasoline engine driven generator complete (Allis-Chalmers or equivalent), 56 cells of 277 ampere-hour battery, a suitable switchboard and pole line wiring to residences and buildings.

2. Rates for service to average 25c. per kilowatt-hour, up to 30 kilowatt-hours per month, and 20c. per kilowatt-hour for amounts in excess.

3. Rate for housing rental for apparatus, per month, $5.00.

4. Rate for attendant (not over 2 or 3 hours per day), per month, $30.00.

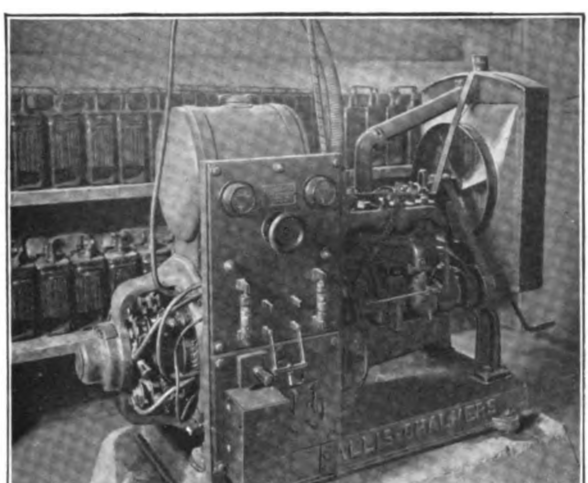
5. Initial cost of total installation, including wiring, meters, etc., $6,000.00.

(Note.—In most cases residence owners will purchase meters.)

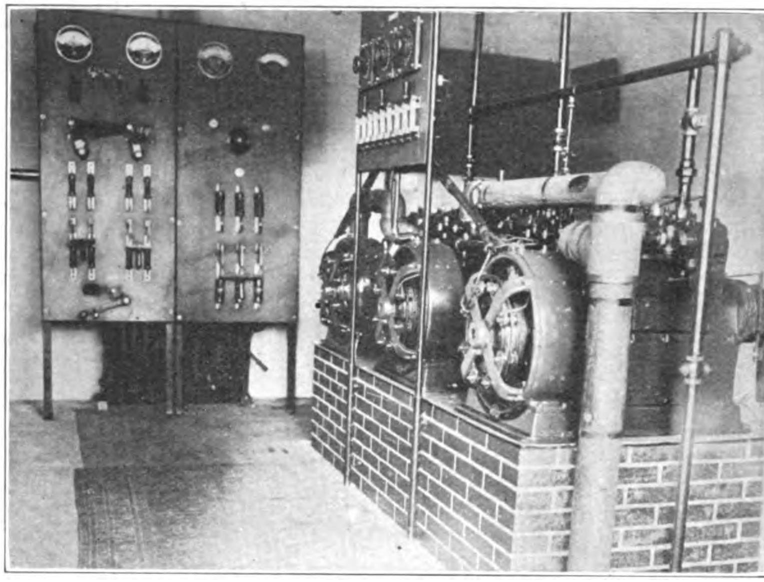
6. Insurance, per year, $25.00.

7. Initial cost of $6,000.00 to be written off in ten years or ten per cent. per year.

In the case of the typical village shown it is entirely reasonable to expect the following market for electric current. Perhaps this may not be fully realized at the outset, but it is thought that the figures given on page following are conservative and show a possible average for, say, a ten-year period.



**Allis-Chalmers 5-Kilowatt Generator Set Installed in Basement of Schoolhouse, Scio, Michigan.**



**Three Universal Sets Comprising the Lighting and Power Plant of Foxboro, Pa. Any two or all three may be run at once.**

The addition of conveniences and necessities of this kind will add to the electrical load each year. So the average returns over a ten-year period are likely to be much greater than those shown.

A reasonable basis to figure residence consumption is ½ KWH. per 24 hours. This to include operation of lights and all accessories. It is the equivalent of operating an electric flat iron for only one hour each day. This amounts to 15 KWH. per month for each residence, or at 25 cents per KWH., $3.75 per month.

If the churches are each lighted with, say, 25 75-watt lights two evenings per week, or, say, a total of 20 hours per month, they will each consume 37½ KWH. per month. At the 20c. rate this amounts to $7.50 per month for each church.

The general stores should each have about ten 75-watt lights and operate on an average of, say, three hours per evening 25 days in the month the year round. The current consumption will amount to 56¼ KWH. per month, or, at the 20c. rate, $11.25 per month for each store.

If the garage is equipped with a ½ H. P. motor which operates, say, three hours per day, to furnish power for tools and compressed air for tires, and ten 50-watt lamps used on an average of six hours per day the KWH. consumption per month, 25 days, will be 112½. At the 20c. rate this amounts to $22.50 per month for garage power and light.

The feed mill may average two hours per day with a 2 H. P. motor, or about 100 KWH. per month. This at the 20c. rate is $20.00 per month.

Provided the movie operates two evenings per week, five hours per evening, it is safe to assume 160 KWH. current consumption per month or at the 20c. rate a revenue of $32.00 per month.

The amount of power required on the farms can be almost any amount, depending upon the number of electric motors installed. Assuming an average of 40 KWH. per month, the return from each of the farms served will average $8.00 per month.

**Income and Expense Account Summarized**

The summary of KWH. and monthly income from electric service in the typical village may, therefore, be taken as follows:

| | | | | |
|---|---|---|---|---|
| 34 Residences | 510 | KWH. at | 25c. = | $127.50 |
| 2 Churches | 75 | " " | 20c. = | 15.00 |
| 2 Stores | 112½ | " " | 20c. = | 22.50 |
| 1 Garage | 112½ | " " | 20c. = | 22.50 |
| 1 Feed mill | 100 | " " | 20c. = | 20.00 |
| 1 Movie house | 160 | " " | 20c. = | 32.00 |
| 4 Farms | 160 | " " | 20c. = | 32.00 |
| Total KWH. per month | 1230 | To. inc. p. month | | $271.50 |

Annual fixed charges over a ten-year period during which the total value of the plant will be written off may be taken as follows:

| | |
|---|---|
| Interest—Average per year on $6,000.00 at 7 per cent., making allowance for annual deduction of $600.00 for retiring fund | $231.00 |
| Retiring fund—$6,000.00 at 10 per cent | 600.00 |
| Housing rental—12 months at $5.00 | 60.00 |
| Insurance | 25.00 |
| Total annual fixed charges | $916.00 |

Annual operating expenses will vary according to local conditions. The price of gasoline and oil, amount of repairs required, wages paid attendant are variable quantities. However, based on cost of gasoline at 25c. per gallon, the cost of fuel for these sets should not exceed 5c. per KWH. delivered to user. Based on this cost of fuel, annual operating expenses will run about as follows for the typical village:

| | |
|---|---|
| Gasoline and oil KWH. per month, at 5c. = $61.50; for 12 months | $738.00 |
| Wages of attendant 12 months at $30.00 | 360.00 |
| Contingencies, repairs, etc. | 100.00 |
| Total annual operating expense | $1198.00 |

**Summary**

| | | |
|---|---|---|
| Annual net income, 12 months, at | $271.50 = | $3258.00 |
| Annual fixed charges | 916.00 | |
| Annual operating expense | 1198.00 | |
| | $2114.00 | $2114.00 |
| Annual net profit above interest charge | | $1144.00 |
| Annual interest charge | | 231.00 |
| Annual profit including interest charge | | $1375.00 |

Percentage profit on investment $\frac{1375}{6000} = 22.9\%$.

It will be noted that in the example given the total current sold per month is 1230 KWH. The total current produced is somewhat in excess of this amount, depending upon the losses on transmission lines and storage battery.

**How Economies May Be Effected**

These losses may be kept very low if the wiring is properly laid out and the feeder lines made of sufficient size to keep the voltage drop low, and if the plant is managed so that a minimum of current passes through the storage battery. This can be done by leaving the generator in operation at times when the demand for current is the greatest, such as when the moving picture machine is in operation and when the larger electric motors are in use.

Based on one-fourth of the total current sold being passed through the

storage battery having an efficiency of, say, 80 per cent., the storage battery loss is approximately 76.5 KWH. for the month.

If the average voltage drop of the lines is 5 volts and the distribution based on 10 hours per day, 30 days per month, or 300 hours, the line loss for a delivery of 1230 KWH. will amount to approximately 55.5 KWH. for the month.

The generator under these conditions will have to produce 1230 + 76.5 + 55.5, or a total of 1362 KWH. It will be noted that the distribution losses are within 10 per cent.

In order to produce 1362 KWH. per month of 30 days the 15 KW. generator operating at full load will only have to operate about three hours each day.

$$\frac{1362}{15 \times 30} = 3.02 \text{ hours.}$$

Now the matter of the size of feeder wires is an important one. It is desirable to keep the initial wire cost as low as possible and at the same time to eliminate unreasonable line losses. As a rule a voltage drop of 10 volts is permissible at the most remote point of distribution.

Voltage drop may be figured from the following formula:

$E = IR$. Where $E$ = Voltage drop.

or $R = \frac{E}{I}$ $\quad$ $I$ = Current in amperes.

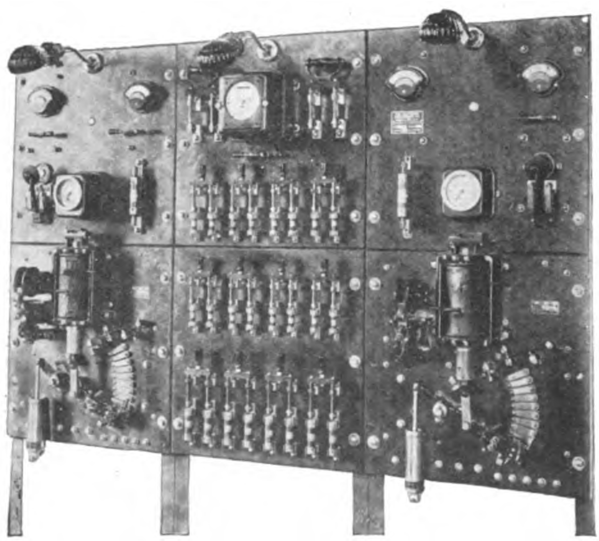
$R$ = Resistance in ohms of entire circuit.

The resistance R is obtained by multiplying the resistance per foot of a given size wire by the total length of the circuit in feet. The resistance per foot of different sizes of wire are given in tables in this book. See Index. Or wiring may be figured from the following formula:

$R = \frac{L \times 10.81}{C}$ Where $R$ = Resistance in ohms of entire circuit.

$L$ = Length of wire total (twice distance from generator to user).

or $C = \frac{L \times 10.81}{R}$ $\quad$ $C$ = Circular mils area of wire proposed.

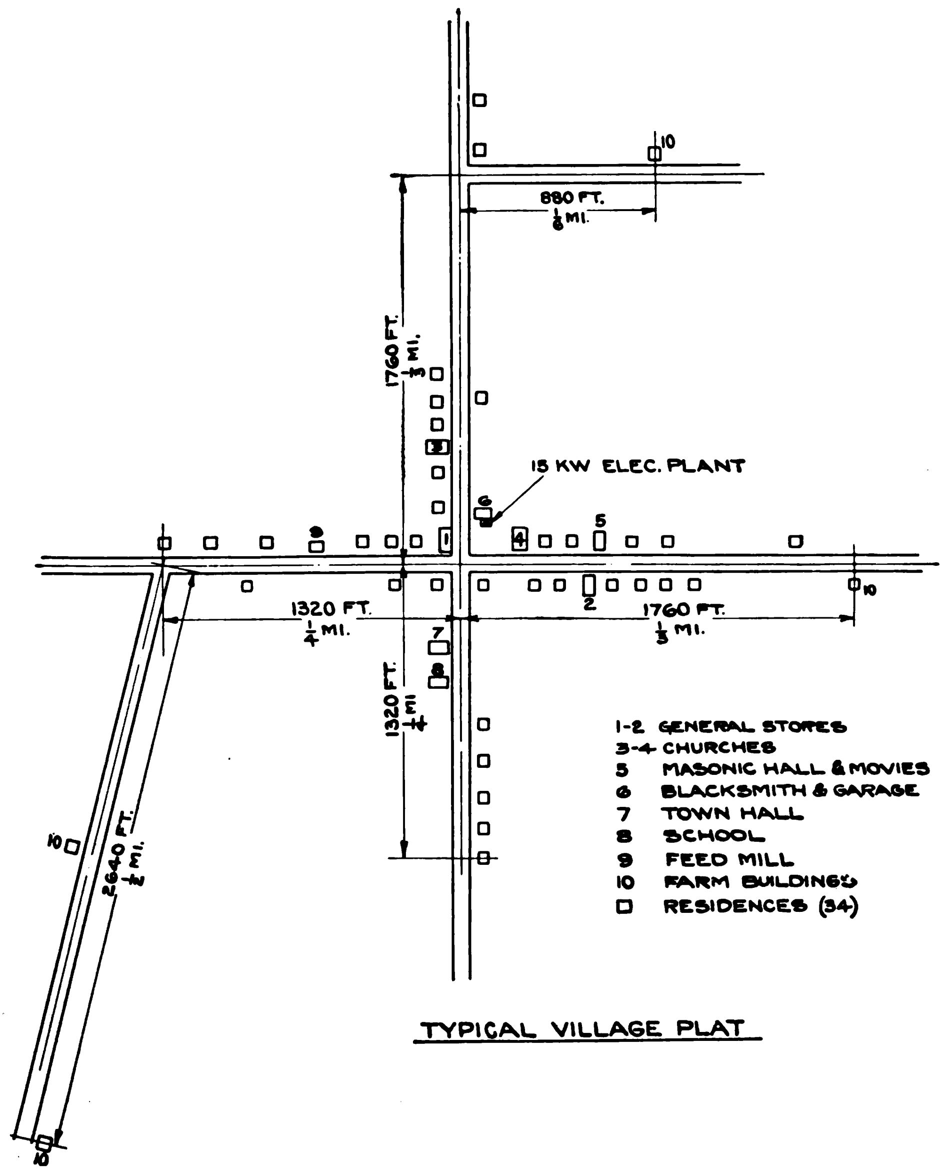


**Switchboard of Two Matthews Automatic Plants Used for Light and Power on a Large Farm. The generators are connected to run in parallel when necessary.**

## Figuring Size of Wire Needed

Very convenient electric wire computers enabling one to determine at a glance the size of wire to meet a given condition are available and are a great help. Such a computer is, for instance, included in the handbook of the Okonite Company, Passaic, N. J.

As a concrete example, take the case of the farm buildings ten in the typical village plat given here. They are located three-quarters of a mile, 3,960 feet, from the generating plant. If this customer's average demand is




TYPICAL VILLAGE PLAT

**Make a layout or plat of your village and submit it with an estimate of the cost of the equipment complete, the expense of operation and maintenance and the estimated income. Know your subject thoroughly and you can sell the most hard-headed financier.**

for the operation of, say, a one H.P. 110-volt motor, or about eight amperes, and the permissible voltage drop is 10 volts, the size of the feeder wires may be figured as follows:

$$10 = 8R \qquad R = 1.25 \text{ ohms.}$$

$$C = \frac{3960 \times 2 \times 10.81}{1.25}$$

$$= 68{,}492 \text{ circular mils.}$$

The nearest size B. & S. gauge wire is No. 1, which has 83,690 C.M.

If this same customer's demand averages only six 25-watt lights, or, say, 1.3 amperes, a No. 9 B. & S. gauge wire could be used for a voltage drop of 10 volts.

On the other hand, if the one H.P. motor were only one-quarter mile from the generator,

$$C = \frac{1320 \times 2 \times 10.81}{1.25}$$

$$= 22{,}830 \text{ circular mils.}$$

The nearest size B. & S. gauge wire is No. 7, which has 20,820 C.M.

It is obvious that when a heavy feeder wire is installed to take care of a remote customer using considerable current, the average voltage drop of the line for customers served from the same feeder, who are located near the plant, is greatly reduced.

In general, it is economy in the end to have feeder wires a little too large rather than too small. This policy will result in more satisfactory service to customers, and in an actual saving of fuel.

### How Dealer May Finance Purchase

In regard to the financing of the purchase of a village plant various methods are pursued, depending upon the locality. It has been demonstrated that if dealers are willing to go after this class of business in a systematic way, expend the energy and thought required and apply the principles of salesmanship, handsome returns may be realized.

Here is an outline of one method of procedure, which has proven successful in the sale of these plants. Practically every village or town is favored by having some outstanding individual who is an acknowledged leader in his community. The first move is to seek him out and get him interested, interview others in the town and get general interest aroused.

Then make a layout of the village, similar to that shown here, and make a complete analysis of possibilities for sale of current, cost of wiring, installation and operating expenses along lines suggested above. With this information in hand make up a prospectus in an attractive, businesslike manner for the organization of a small company and circulate it for subscriptions.

In some cases it will be found that this company can be composed of only a few of the citizens. In others, it is advisable to have quite a number of stockholders.

If the dealer takes the initiative by furnishing complete information as to what can be expected of the plant, and gets this information together in a neat prospectus with a place for subscriptions, and is successful in arousing general interest, he will find, in the majority of cases, that some of the leading men of the community will take the matter in hand and help to get the money together to finance the purchase of the plant.

In some localities the local banks will be of great help in promoting the proposition. In the first place, it is necessary to have a sound business proposition, then it must be properly presented. If this is done there is certain to be a way to finance it. The dealer who can perform a real service to his community is the dealer who eventually reaps the reward. The beginning of true salesmanship is service. This open field, the furnishing of electrical service to towns and villages, presents a remarkable opportunity for service and salesmanship. The publishers of Farm Light and Power will be glad to lend any assistance possible in compiling prospectuses and the like to dealers seeking to obtain orders for this type of equipment.

# Installing and Handling Batteries

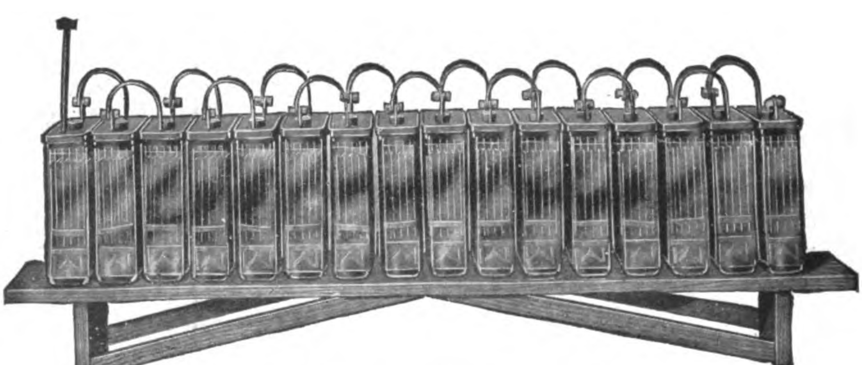
### Location of Battery

TO obtain the greatest economy, the battery should be located near the central part of the lighting load—that is, taking an average farm, for example, there are a few lights in the barn and outbuildings, but the largest number of lights are in the house, therefore the battery should be placed in the basement, provided it is not too damp. While it is desirable, in many ways, to have the battery near the plant proper, still this is not absolutely necessary, but it will require larger size wires in making the connections to the switchboard if the battery is located at any appreciable distance from the plant. For the most efficient working the battery should be kept warm, which is another reason for location in basement. On the other hand, it is entirely feasible to locate the battery in an outbuilding, but battery must be kept well charged in cold weather to prevent freezing. A cold battery will not deliver its charge as fully as when in a normal temperature.

### Care of Storage Batteries

Storage batteries require careful attention, since no system can be any more powerful than its source of energy. In other words, the storage batteries are the business end of every electrical starting and lighting system. Just as the most elaborate and reliable ignition apparatus is of doubtful value with poor spark plugs, so the finest generators, motors and auxiliaries become useless if the battery is not in proper working order.

A little experience in the maintenance of electric lighting and power plants having storage batteries will demonstrate very forcibly that the relative importance of the batteries is totally disproportionate to that of all the remaining elements of the system put together. The latter essentials have been perfected to a point where they will operate efficiently without attention for long periods. The batteries, on the other hand, require a certain amount of attention at regular and comparatively short intervals. Usually this attention is not forthcoming, or it may be applied at irregular intervals, and with



Method of Installing Cells in Single Group

but scant knowledge of the underlying reasons that make it necessary. Consequently the batteries suffer. It is abused more than any other single part of the entire plant, and not being so constituted that it can withstand the effects of this abuse and still operate efficiently, it suffers correspondingly. Then the entire system is condemned. Other things being equal, the suc-

*Illustrations courtesy Phelps Power & Light Company, Rock Island, Ill.*

cessful operation of any lighting plant using storage batteries centers almost wholly in the proper maintenance of the storage batteries. Not all the defections that this part of the electrical equipment of the plant suffers are caused by the batteries, but unless properly cared for it will be responsible for such a large proportion that the shortcomings of the rest of the system will be entirely forgotten. To make it even stronger, it may well be said that unless the batteries are kept in good condition the rest of the plant will not have an opportunity to run long enough to suffer from wear.

### Precautions Against Freezing

In addition to taking care that the temperature of the cells does not exceed 100° F. on charge, precautions are also necessary to prevent the temperature of the battery falling too low, as a drop in the temperature causes a falling off in the efficiency. To avoid this the battery should always be kept fully charged in cold weather, as a charged cell will not freeze in the temperature ordinarily experienced.

The electrolyte in your batteries will freeze at the following temperatures when the specific gravity is as follows:

Specific gravity 1150—20° Fahrenheit above zero
Specific gravity 1215—20° Fahrenheit below zero
Specific gravity 1250—50° Fahrenheit below zero
Specific gravity 1285—85° Fahrenheit below zero

Care should be taken not to let the temperature of the place in which the battery is kept to fall below 20° F., or else the battery should be kept fully charged.

### Storage Battery Instructions

The battery must be properly installed and securely fastened in place. It should be accessible to facilitate the regular adding of water and testing of electrolyte. If put in a compartment it must be ventilated, drained, not allowed to get wet, nor become covered with oil or dirt, and should not be made so as to allow opportunity for anything to be laid on top of battery compartment.

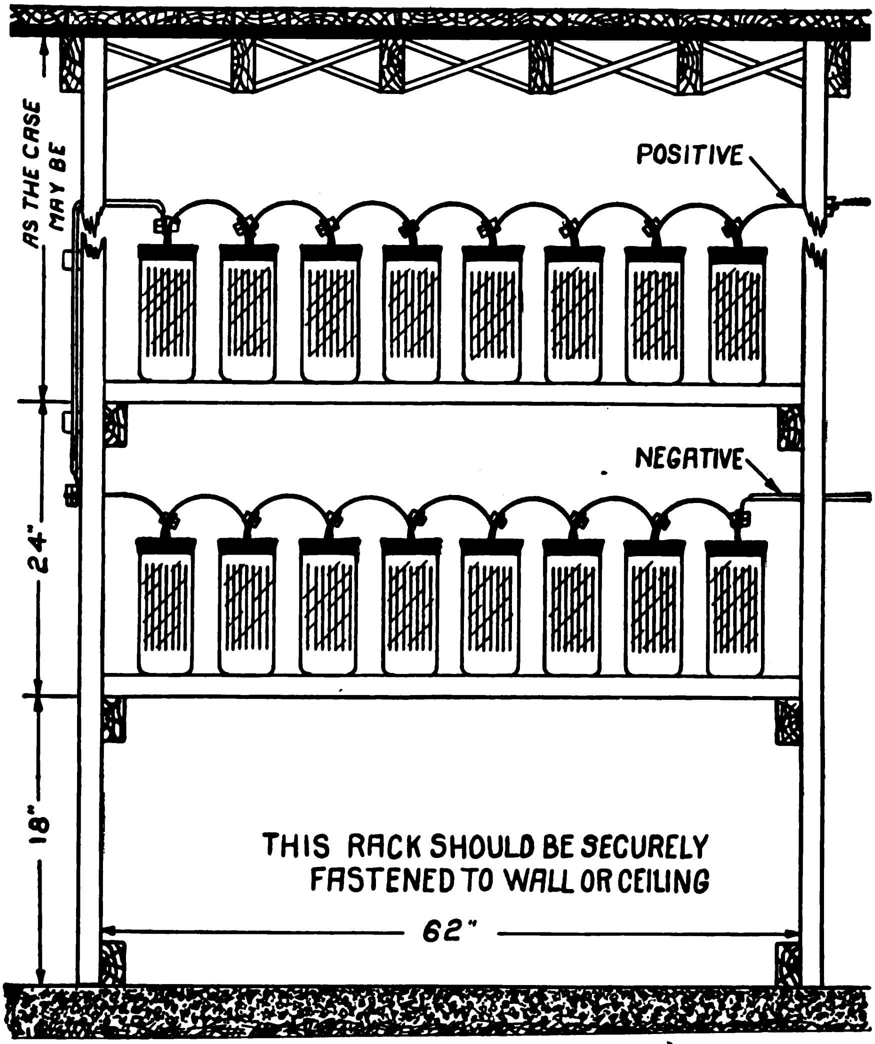
Battery should have free air-space on all sides, and all small articles, especially of metal, should be kept out of and away from the batteries. The terminals and connections should be kept coated with vaseline or grease. If electrolyte has spilled out, it can be cleaned off with rags or waste moistened with a little ammonia water.

Nothing but pure water (distilled water or rain water that has not come in contact with iron and is perfectly clean) must be added to the cells, which should be done regularly and at sufficiently frequent intervals to keep the electrolyte at the proper height in each cell. The electrolyte should never be allowed to go lower than one-half inch above the tops of the plates. Spacing in cells vary somewhat, and correct filling is to fill so that the electrolyte is half way between the top of the plates and the bottom of the cover.

The frequency with which the cells should be replenished with pure water will depend upon the battery, the system with which it is used, and the condition of operation. It should be examined every two weeks. Vent plugs in the top of the cell are removed to put in the water, and should be replaced after cells are replenished with water. Do not use acid nor electrolyte to bring up the gravity of cells or to replenish, except in special cases mentioned hereafter. The only safe water to use is distilled water, rain water caught in the open in an earthen vessel, or clean snow melted in an earthen vessel. This water should be kept in a closed earthen or glass jar, so it will not become contaminated. Never use a metal funnel to pour water into the cell.

The best way to ascertain the condition of the battery is to test the specific gravity (density) of the solution in each cell with the hydrometer.

This should be done regularly. A convenient time is when adding water, but the reading should be taken before rather than after adding the water. A




reliable specific gravity test cannot be made after adding water, and before it has been mixed by charging the battery.

To take a reading, insert the rubber tube in the cell. Squeeze and then slowly release the rubber bulb, drawing up the electrolyte from the cell until the hydrometer floats. The reading on the graduated stem of the hydrometer at that point where it emerges from the solution is the specific gravity of the electrolyte. After testing, the electrolyte must always be returned to the cell from which it was drawn. The gravity reading is expressed in "points," the difference between 1,250 and 1,275 being twenty-five points.

### Battery Racking

The battery should be placed on a strong rack or heavy shelving, where it is easily accessible and well ventilated, and we recommend painting the

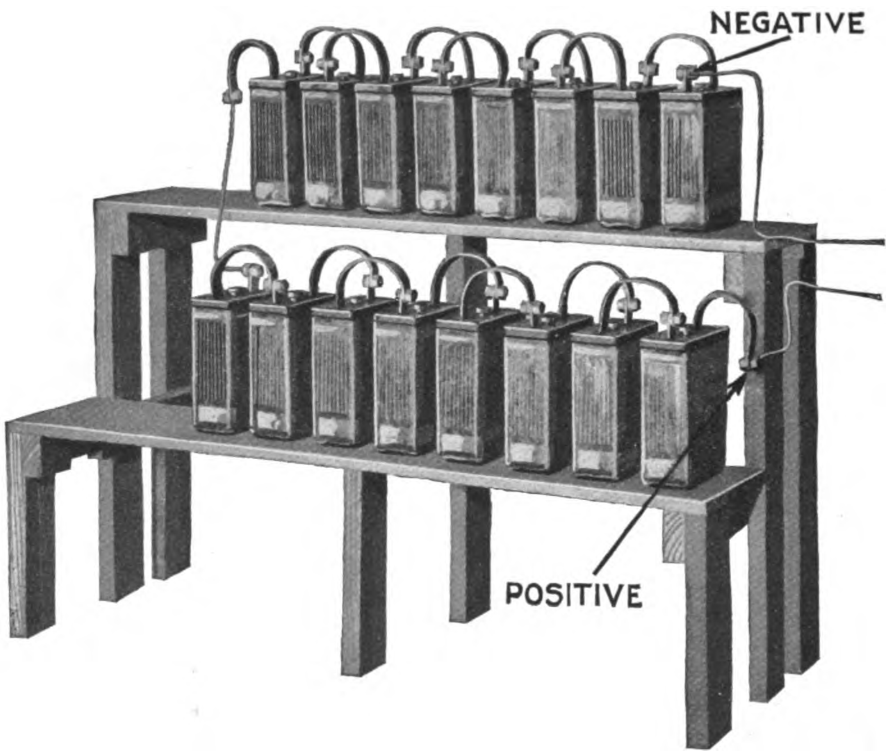
rack or shelving with asphaltum or acid-proof paint. Keep battery out of the direct sunlight.

In event that the available space will not allow of the placing of the cells in one row, they may be arranged in two rows.

A loose or dirty contact on the cell pole will cause excessive heating, and may be detected by feeling the connector after current has been passed through for some time. If a hot connection is located, the connector must be removed and the contact surfaces cleaned with fine emery cloth, scraped or filed.

### Unpacking Batteries

Battery cells are carefully placed and packed in specially designed boxes to keep them upright during shipment. Remove cover from battery boxes and carefully remove cells, wiping off any packing that may lodge on top of the cells. **Do not lift cells by straps.** Wipe off all dust and inspect each cell to determine if any have been damaged in transit. If a cell should be




broken, the plant can be operated temporarily by connecting around the bad cell. If there is any damage to any cells, have repaired or replaced with new cells at once.

As soon as cells are unpacked place on permanent battery rack or shelf. Starting at one end, place first cell—allow a full inch space between cells, use an inch block of wood to space cells—set second cell so that long strap will bend and connect to short strap of first cell, set the balance of the cells with the same spacing, being sure to always connect a long strap to a short strap of the cell next to it. In bending the long straps, do not make short bends, form a long curve in the soft metal with your hands. Clean ends of straps of each cell where connections are made, dip bolts and nuts in vaseline or cup grease before bolting up.

Bolt straps together as cells are put in position on shelf or rack, set lead head nuts up tight. Do not use other than lead head bolts and nuts. While setting up cells see that electrolyte level is half way between top of plates and bottom of cell cover. If electrolyte does not cover plates, unless sloppage is more than two inches from top of plates, fill with distilled water or rain water caught in the open in a clean earthen vessel, or clean snow water melted in an earthen vessel. Water from a well or cistern is NOT safe to use.

If the battery has been connected properly you will have a positive (+) terminal at one end of the battery series and a negative (—) terminal at the opposite end. It is a good idea to take notice again and see that each cell is properly connected so that a positive (+) terminal always connects with a negative (—), and vice versa.

## BATTERY REQUIREMENTS

1. **Use distilled water only** (boiled water or well water will destroy your battery).
2. **Replace electrolyte evaporation** (with distilled water only).
3. **Alcohol or anti-freeze mixture will ruin your battery.**
4. **Keep battery away from hot exhaust pipe or furnace.**
5. **Keep batteries out of direct sunlight** (artificial heat destroys the plates).
6. **If you think you can do without lights and power, after experiencing these advantages, forget to keep your battery charged.**
7. **The electrolyte must cover the plates one-half inch.** (Dry plates or plates exposed to the air will not hold a charge.)
8. **Overcharge your battery once a month.** (This freshens the battery—like a good sleep for a tired man.)
9. **Add water every two weeks** (if you don't want your battery to die of thirst).
10. **Keep all connections tight and nuts and bolts covered with vaseline.**

# Charging the Battery

In order that current may flow in a circuit, the voltage of the current must be sufficient to overcome the resistance in the circuit. In the case of a circuit including a storage battery, there is, in addition to resistance, a back e. m. f., or voltage, produced by the battery itself. The voltage of the generator must accordingly be greater than that of the battery, plus that required to overcome the resistance of the circuit, in order that it may charge the battery. For this reason generators are wound to produce current at 32 to 40 volts, 115 to 125 volts, although the voltage of the lamps and other appliances to be used in their circuit are 32 and 110 volts. Even when fully discharged, each cell of storage battery will still show two volts on a voltmeter. As the charge increases the voltage of each cell also rises slightly, so that as the end of the charge approaches each cell will produce current at close to 2½ volts, or 40 volts for a 16-cell battery.

### Charging Rates

Charging rates of a battery are based on a charging time of eight hours in the same manner as the discharge rate of the same battery is based on an eight-hour period of discharge. This does not necessarily mean that eight hours must be consumed in charging the battery or that it cannot be disharged in a shorter period than eight hours. Batteries may be either charged or discharged at higher or lower rates, though both their efficiency and capacity are decreased in proportion as the rate of charge and discharge is increased, while they become correspondingly more efficient as the rates of charge and discharge are decreased. In other words, slow charge and slow discharge add greatly to the efficiency and life of the storage battery.

### Battery Efficiency

Every transformation or conversion of energy is accompanied by a loss. In charging a storage battery electrical energy is converted into a chemical form and there is a loss of approximately 10 per cent. in the process. Drawing current from the battery, or discharging it, is the reverse of this process, and consists of converting energy in chemical form back to electrical form. It is also accompanied by a loss of approximately 10 per cent., so that for each 100 ampere-hours delivered by the generator to the battery the battery will only deliver 80 ampere-hours, provided it is in good operating condition. Any lack of care, neglect, faulty practice in charging, discharging at too high a rate, discharging too low, not keeping the cells properly filled, allowing them to become overheated when charging, or allowing them to become too cold, will reduce this percentage of efficiency.

For a continuous, steady charge, the average current required to charge a battery at the normal rate for the eight-hour period can be figured as one-sixth ampere for each ampere-hour capacity of the battery. For example, a 60 ampere-hour battery would require 10 amperes. For a 160 ampere-hour battery it would be 26 2/3 amperes.

In practice, however, it is desirable in charging lead batteries to begin the charge at a very much higher rate and reduce it toward the completion of the charge, which is termed "tapering." The ampere rate for the beginning of the charge may accordingly be double the normal amperes used, this being continued until the cells begin to gas freely, when the charging rate should be reduced to about half the normal.

For high battery efficiency and economy it is necessary to charge at a low rate. A completely discharged battery should never be recharged in a period of less than five hours, and the battery will be kept in a very much better operating condition if the charge is never completed in a period of less than eight hours, with a long, slow charge extending over 12 to 14 hours

once every month or six weeks. The latter is absolutely necessary to keep the battery in good operating condition, as a little sulphate is left in the plate even after a complete eight-hour charge, and this accumulates with each charge, so that every fifth or sixth charge the battery is given should be one of the long, slow charges mentioned. There is no other way of preventing accumulation of sulphate in the plates, and this rapidly cuts down the efficiency.

### Part Charging

Most charging rates and tables given are based on the theory that the charge starts with a completely discharged cell, but in practice this is not true, since it is very harmful to the cell to discharge it completely. Hence the charging rates must be based not upon the total charge required, but upon a part charge, since there will always be some current in the battery. The range of the specific gravity of the cell being known, a hydrometer test will show very quickly how far the battery has been discharged, and this percentage of discharge may be used in figuring the rates of starting the charge.

### Jamming the Charge

On the theory that a storage battery is simply a tank and can be pushed full by using sufficient pressure, it has become more or less common practice to follow what may best be termed "Jamming the Charge" in recharging the cells. This consists of starting the charge at a very high rate and continuing at this rate until the cells are considered to be fully charged. Needless to add, they can never be fully charged at this high rate, because long before the charge is completed the cells have become so hot that the charge must be stopped, otherwise they will be ruined. As it is, this continued high rate of charging expands the lead grids very badly and forces the active material out of them, so that the life of the cell is shortened to a very great extent, while it is never in as efficient or satisfactory condition as when the charge is extended over a considerable number of hours and the rate of charging is tapered to correspond to the needs of the battery itself, starting with a very high rate when the battery is entirely discharged and decreasing this rate as the battery becomes charged, thus avoiding overheating and buckling of the plates. See "Tapering the Charge."

### Tapering the Charge—Importance of

Since the active life of a storage battery is measured by the length of time that the active material is retained in the lead grid of the positive and negative plates, and more particularly the former, anything that contributes to lengthening the life of this active material is of the greatest importance. The chief cause of the loosening of this active material is overheating of the plates, caused by too heavy charging. This causes the grid to expand and the active material is forced out, dropping to the bottom of the cell as sediment. A storage battery should never be charged any faster than the cell can absorb the current without overheating. An indication of the fact that a battery is being charged too rapidly is the fact that it is gassing violently. The charging rate should immediately be reduced as soon as the battery begins to gas actively, because the gas indicates that the current is being passed through the battery at a higher rate than the battery can absorb it.

The rate of charge possible without doing any harm to the battery depends entirely upon the state of the battery when the charge is begun. If the battery is fully discharged it is possible to start the charge at a very high rate. This may be equivalent to 50 per cent. of the ampere-hour capacity at the start, but it would have to be reduced the moment the cells began to gas.

# The Life of a Storage Battery

THE life of a storage battery in farm lighting service depends upon how hard it is worked, and the care it receives. With first class care the life is dependent more upon the number of cycles of operation than upon the number of years it is in service. A cycle is one complete charge and one complete discharge. Modern farm lighting batteries all have about the same thickness of plate, and it is this thickness of plate that controls the number of cycles that the battery will deliver before it is worn out. When a battery is given about two cycles a week, its life may be estimated at four hundred cycles, which is equivalent to about four years. If the battery is given one cycle per week, it will not deliver the same number of cycles, but will probably give in the neighborhood of three hundred cycles, which is equivalent to a life of six years.

The reason for this difference in the number of cycles given is that all the time the plates are immersed in sulphuric acid, they are subject to a local action, the acid attacking the lead. This goes on very slowly, but eventually eats through the grid and results in the battery's failure. This rotting action is helped along by the charging and discharging of the battery, particularly on the positive plates, which have the hardest work to do.

### When a Battery Is Worn Out

When a battery is charged, the material in the positive plate is changed by the action of the current from a lead sulphate to a lead peroxide. When a battery is discharged, the positive plate changes from lead peroxide to lead sulphate. These changes are not complete—that is, the whole of the positive plate does not change, on each charge and discharge, but as much of the material as is reached by the acid does change. This chemical change is accompanied by an increase and decrease that gradually loosens up the material and causes it to lose its hold upon the body of the plate and fall to the bottom of the jar. When the amount of material that has thus dropped off becomes so large as to diminish the capacity of the battery to an unsatisfactory point the battery is worn out and must be replaced. Naturally the thicker the plate the more cycles it will give, provided the material and workmanship are equally good in both plates and the care and conditions are the same.

Many storage batteries on farm light plants do not receive the proper care, which is assumed to be given in the preceding paragraph. In all cases this lack of care will shorten the life and diminish the service that the battery will give. There are several ways of abusing a battery, the most common of which is undercharging. When a battery is undercharged, the gravity gradually goes lower and lower, and the plates become more and more converted to lead sulphate. As this goes on the plates swell until the grids break apart, thus cutting off the plate from contact with the electrical system, or if the grids still hold, the plates will warp out of shape, and cut their way through the wooden separators until they touch the negative plates. This will short circuit the battery and in either case result in battery failure. In bad cases of undercharging the battery may go to pieces in six months, while in slight cases 80 per cent. of the normal life may be realized.

### Some Forms of Battery Abuse

Another abuse to which farm lighting batteries are subjected is that of overcharging. This abuse is to be most commonly looked for when the battery is charged every day, while the plant is being used to furnish power direct from the engine for some other purpose than running the light plant. This overcharging hastens the wearing of the active material in the positive plates because of the action of the gas bubbles which are formed during the

*Contributed by R. M. Mowry, Universal Battery Co., Chicago, Ill.*

charge and because the lead suphate, which acts like the cement in concrete, is destroyed. In some cases, charging is done at a very high rate, which is particularly harmful to the battery when the charge is nearing completion. High charging rates result in a very rapid formation of gas bubbles, and these tend to blow the material right out of the grids. The life of the battery that is constantly overcharged will usually be from one year to three, although two years is the average life under these conditions.

Another reason for batteries failing to last their normal life is because they contain impurities. The most common way for these to get into the battery is for the owner to add water which is not pure or to try to bring his battery up by adding some sort of acid or "dope"* in place of giving them a charge. If these impurities are metallic, such as copper and iron, both of which are frequently met with in farm waters, the effect is to discharge the battery while standing idle. It then requires more frequent charging, and so will lessen its life.

### Damage Resulting from Impurities

If the impurities are acid, such as might be put into the battery by using water from a new shingle roof or if there are other impurities such as common salt, also a frequent impurity found in farm water, the effect will be to destroy the grid, letting the material fall apart. These impurities have a very rapid action and two years' service is about all that can be obtained from a battery when an impurity such as common salt gets into the electrolyte.

The fourth common cause for batteries failing to give the life they should is that of over-loading. In this case, too small a battery is installed for the work to be done, or else the owner puts on a considerable extra load after he has had the plant installed, so that the capacity of the battery is used up every day or every other day, and charging must be done four times a week or more. In this case, the battery will last until the normal number of cycles have been used, which is in the neighborhood of four hundred cycles for the glass jar type of battery, now in such extensive use.

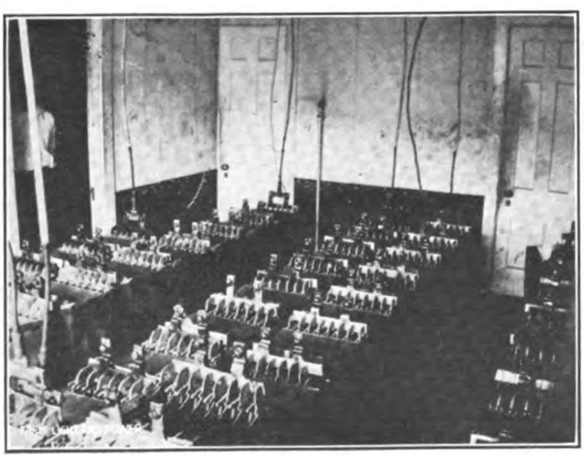
### Replacements Needed

When a battery has reached its normal life or has worn out because of abuse, all of the material does not need to be scrapped. The glass jars can be used until broken by accident. This is true whether the battery wears out normally or has been abused. In the majority of farm light plant batteries, when the battery has worn out normally, the positive plates only are gone and the negatives are, as a rule, in good enough condition to be used again. In this case, the battery can be put in as good condition as new by a positive renewal; that is, replacement of the positive plates. A positive renewal means that only new positive groups, separators and a small amount of acid are necessary. If there is a local battery service station, this work may be done more cheaply locally than by shipping the battery back to the factory for repairs or replacement. This work is not difficult, does not require a very large amount of equipment and can be done quite cheaply by a service station properly equipped for it.

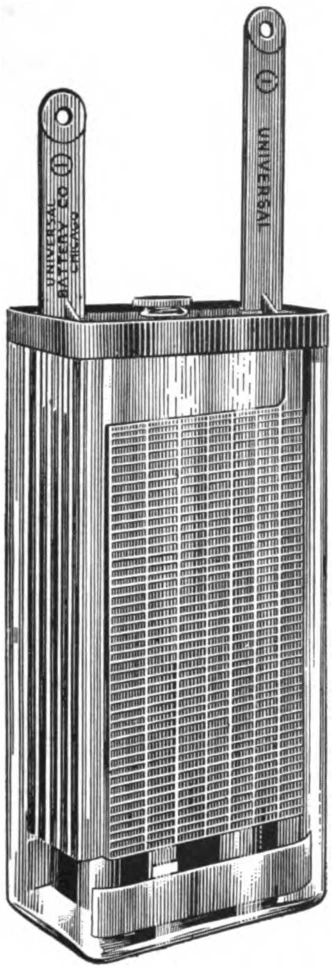
### Some Abuses Ruin Entire Cell

When the battery has failed because of improper care it is not always possible to repair it. If the abuse is undercharging, in most cases, a positive renewal such as described above will do the work in a satisfactory manner. If the abuse is overcharging, in about half the cases, a complete renewal is necessary—that is, all parts but the glass jars must be replaced. If the cause of the battery's failure is impurities, then the only safe way to do is to have the entire battery replaced or at least have everything new but the glass jars. If the battery has been over-loaded, in most cases, a positive

*See chapter on "Use of Dopes and Powders."



*This will give you some idea of the sales possibilities in your field. The picture shows a 560 ampere-hour, 64-cell Gould storage battery that is kept charged by a wind-driven plant. The battery alone cost several thousand dollars.*

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renewal will put it into first class condition again, but the proper thing to do is to replace it with a larger set of batteries.

Where it is necessary to give a battery a complete renewal, it is always best to get a figure from the factory on a replacement of the whole battery, as quite often this is more economical than to do all of the work locally. It also gives the owner a chance to secure cheaper battery service by putting in a larger battery which will give longer life. For instance, if an 80 ampere hour battery has given three years of service, a 160 ampere hour battery will give practically twice the life at only fifty per cent more cost. Thus the replacement or repair of the storage battery on a farm lighting plant not only gives the dealer another source of dependable income, but also gives him a chance to lower his customers' battery service costs by installing the proper size or pointing out just what fault must be corrected to get longer life and more satisfactory service.

## BATTERY DISCHARGE TABLE

| Rate of Continuous Discharge Amps. | × Volts | = Watts | Equivalent Load in Lamps, Motors, Etc. | Time Load Can Be Carried Continuously: 60 A.H. Batt'y Hours | 80 A.H. Batt'y Hours | 160 A.H. Batt'y Hours |
|---|---|---|---|---|---|---|
| 1 | 32 | 32 | 2-15-watt lamps | 60 | 80 | 160 |
| 2 | 32 | 64 | 1-40, 1-25-watt lamps | 27 | 35 | 80 |
| 4 | 32 | 128 | ⅛ h. p. motor | 12 | 16 | 36 |
| 6 | 32 | 192 | ⅛ h. p. motor, 1-40, 1-25-w. lamps | 7 | 9½ | 22½ |
| 8 | 32 | 256 | Vacuum cleaner and churn | 4 | 6¾ | 16 |
| 10 | 32 | 320 | ¼ h. p. motor, 3-25-watt lamps | 3½ | 5 | 12 |
| 12 | 32 | 384 | Milking machine and churn | 2¾ | 4 | 9½ |
| 14 | 32 | 448 | Cream separator, churn, lights | 2 | 3¼ | 8 |
| 16 | 32 | 512 | ½ h. p. motor, 1-25-w. light | 1½ | 2¾ | 6¾ |
| 18 | 32 | 576 | Washing machine, vac. clnr., churn | 1¼ | 2¼ | 6½ |
| 20 | 32 | 640 | 6½-lb. iron | 1 | ?2 | 6 |
| 22 | 32 | 704 | Iron, 2-25, 1-15-watt lamps | ¾ | 1¾ | 4½ |
| 24 | 32 | 768 | S. W. pump, milking machine, vac. cleaner | | 1⅓ | 4 |
| 26 | 32 | 832 | Iron and vacuum cleaner | | 1¼ | 3½ |
| 28 | 32 | 896 | Washing machine, milking machine, lights | | 1 1/5 | 3¼ |
| 30 | 32 | 960 | ½ h. p. motor and lights | | 1 | 3 |
| 35 | 32 | 1,120 | Deep well pump and washing machine | | | 2½ |
| 40 | 32 | 1,280 | Do, vac. cleaner, churn, lights | | | 2 |
| 45 | 32 | 1,440 | Do, milking machine, washing machine | | | 1¾ |
| 50 | 32 | 1,600 | Washing machine, water system, ironing machine, lights | | | 1½ |
| 55 | 32 | 1,760 | Iron, deep well pump, washing mach., vac. cleaner | | | 1¼ |
| 60 | 32 | 1,920 | ½ h. p. motor, milking machine, churn, cream sep., vac. clner. | | | 1 |

* The above figures are based on a continuous discharge for the time given. When a battery is discharged intermittently, as is usual in ordinary service, it will give its full rated capacity.

# What You Can See in a Storage Battery

WITH a little practice in seeing you will be able to find a great many things about a battery which might otherwise be unnoticed. When you look at a farm electric plant's battery get in the habit of seeing whether:

1—The electrolyte is at the proper height in all of the cells.

2—Whether all the plates and separators are in proper position.

3—Whether the negative plates are light gray, dark gray or dark gray with white powder on the surface.

4—Whether the negative plates are cracked, or buckled, or if the active material is falling out in lumps.

5—Whether the negative plates are blistered.

6—Whether active material of the negative plates is swollen out beyond the surface of the grids.

7—Whether there is a mossy deposit on top of the negative plates.

8—Whether there is much sediment in the bottom of the jar.

9—The sediment is dark brown, light brown, gray or white. (If the sediment is deposited in layers of different color, note the amount and color of each, beginning at the bottom. Note also whether the layers are composed of fine or lumpy material.)

10—Whether the positive plates are a dark chocolate color, dark brown or light brown.

11—Whether the positive plates are cracked, buckled or if the active material is falling out in lumps.

The above observations are not all that could or should be made, but it is the aim here to omit everything in the nature of "tests" and be limited to those observations which can be made without touching the battery. To make application of some of the foregoing, note the condition of the cell shown in figure one.

1—The height of the electrolyte cannot be noted from the cut, as the edge of the jar was broken away before taking the photograph.

2—All the plates and separators are in proper position.

3—The negative plates are light gray.

4—The negative plates are cracked, buckled and the active material is falling out in lumps.

5—The negative plates are not blistered.

6—The active material of the negative plates is not swollen out beyond the surfaces of the grids.

7—There is no mossy deposit on top of the negative plates.

8—There is about one-eighth of an inch of sediment in the bottom of the jar.

9—The sediment is light gray and lumpy.

10—The positive plates are light brown.

11—One positive plate is slightly cracked, none are buckled and the active material is not falling out in lumps.

Sometimes a single observation will tell a story by itself, but more often it is necessary to combine several observations. Combining the answers to questions 3 and 4 you will note that (3) the negative plates are of a light gray color, that (4) the negative grids are cracked, buckled and the active material is falling out in lumps.

The light color indicates prolonged undercharging. That is, some of the sulphate had been allowed to remain in the plates until it became lighter in color and at the same time it became hard. If you could get at the plates in this light gray condition and scratch the surface with the point of a knife it would sound like scratching hard cement.

*Contributed by D. M. Simpson, General Lead Batteries Co.*

While in this undercharged and hardened condition, the battery was overdischarged. The overdischarging, that is, the forming of more than a normal amount of sulphate, tended to make the active material expand, but as the material was too hard to expand by stretching, it expanded by buckling and cracking the grid.

Further overdischarging formed still more sulphate which made room for itself by pushing the material out in small granular lumps as shown sticking out from the surface of the negative plates. Also, some of the lumps have fallen to the bottom of the jar as shown in answers to questions 8 and 9.

To continue operating in the same way, the active material of the negative plates will continue to disintegrate into light granular lumps until the entire mass is in the bottom of the jar or lodged in the meshes of the grids.

The proper operation of the cell will restore it to practically full capacity and greatly prolong its life. To do this, the battery should first be given a full charge at a rate low enough to avoid hard gassing. This may require seventy-five to one hundred hours. Thereafter, charges may be given at the normal rates, although the charges should be continued a little longer each time than in the past.

When the charge is completed the active material of the negative plates will be restored to a soft spongy lead which will have a dark gray color. Of course the charging will not straighten the buckled plates nor heal the cracks in the grids, but there is probably enough conductivity left in the grids to carry the current for normal discharge rates.

Referring to numbers 8 and 9, the amount of sediment in the bottom of the jar is not great, but there should never be any gray lumpy sediment at all. It indicates prolonged undercharging followed by overdischarging; and although the amount of sediment at present is not great, yet the plates are in a condition to throw down more gray lumpy sediment very rapidly under the past method of operation.

In 10 and 11 you have noted that the positive plates are of a light brown color and that one positive plate is slightly cracked. The light brown color indicates undercharging and the cracked grid also indicates undercharging but followed by overdischarging.

To continue undercharging and overdischarging would cause the positive plates to turn a little lighter brown. The grids would crack more, prob-

Fig. 1

**Study these cells and get in the habit of studying the cells of your customer's batteries every time you see them. In a year or so you'll be able to size up almost any battery condition at a glance.**

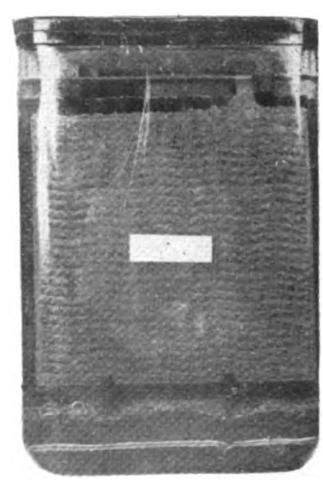
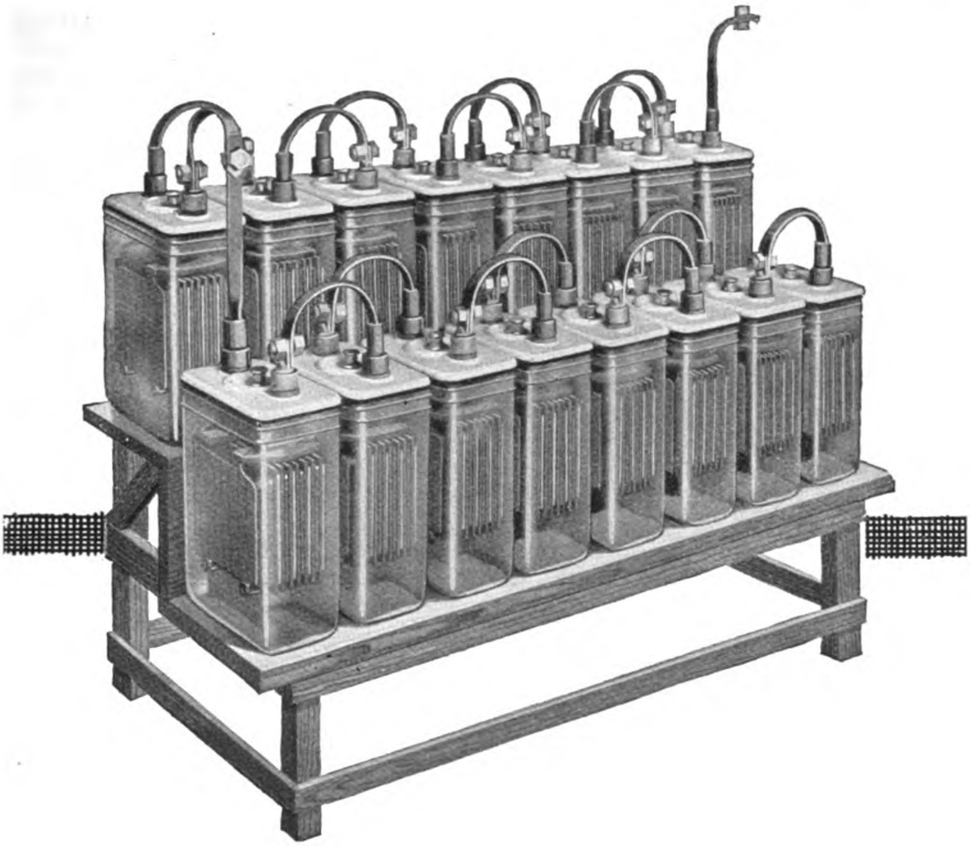


Fig. 2



There is the same quality in this type "P H" Willard Farm Lighting Battery as in the Willard Automobile Battery. Glass jars, well sealed, porcelain covers. Suspension of plates from covers, and large size of sediment chambers, makes cleaning unnecessary during the battery's lifetime. In addition to Willard quality—the best looking battery on the market.

**WILLARD STORAGE BATTERY COMPANY, Cleveland, Ohio**

# Willard

THREADED RUBBER BATTERY

ably buckle and the active material of the positive would crack and fall out in lumps.

Proper operation, as already outlined, will restore the positive plates to a dark brown color, and the cracks in the grid would not interfere with discharging the battery at normal rates.

To make further application of the same questions, note the condition of the cell shown in figure two.

1—The electrolyte is at the proper height.

2—The plates and separators are all in proper position.

3—The negative plates are light gray.

4—The negative plates are not cracked or buckled, but the active material is beginning to fall out as shown along the bottom of the plate and the lower left hand edge.

5—The negative plates are not blistered.

6—The active material of the negative plate is swollen out beyond the surface of the grid.

7—There is a mossy deposit on top of the negative plates.

8—There is about an inch and a quarter of sediment in the bottom of the jar.

9—In the bottom, just on top of the sealing compound, is about an eighth of an inch of fine white sediment. On top of this is about an inch of brown sediment, and on top about one-eighth.

10—The positive plates are light brown.

11—The positive plates are neither cracked nor buckled, but the positive material has begun to fall out in lumps.

In reviewing the autobiography of this cell you will note that it left the factory fully charged, the negative active material being in a soft, tough, spongy condition, as shown by the further fact that when in this soft spongy condition the cell was overdischarged. That is, it was fully discharged, and after standing a short time was discharged some more, and the process repeated until more sulphate was formed in the plate than it would hold, so the extra sulphate made room for itself by swelling out the active material as shown. (Swollen negatives always show that just previous to the overdischarge the negatives had been fully charged, otherwise the overdischarge would not have made them swell, but buckle or crack.) The cell was allowed to stand for some time in a fully or partially discharged condition, during which time the sulphate inside and on the surface of the negative plates turned white. This was followed by a recharge which broke up the white sulphate within the plates, but the sulphate on the outside of the negative plates was thrown off and settled to the bottom, making the thin layer of white sulphate shown just on top of the sealing compound.

The above recharge and subsequent recharge were given at a high rate, especially at the finish, when the rate should be low. This high rate at the end of charge caused the cell to gas hard over a long period and thereby throwing down the deep layer of brown positive sediment. This hard gassing is further shown (7) by the mossy deposit on top of the negative plates. This excessive amount of gas coming up through the separators in the grooves next to the positive plates washed some of the active material from the positive plates. This upward circulation carried some of the loose positive material up above the plates. This material could not settle on the top edges of the positive plates because of the upward circulation at that point, but the material settled on the tops of the negative plates was converted into spongy negative as shown. Therefore, whenever there is a mossy deposit on the tops of the negative plates it indicates that at some time the battery had been made to gas hard.

In eleven you have noted that the negative active material has begun

to fall out in lumps. This indicates that the battery was again allowed to stand in an undercharged condition, which allowed the sulphate to harden and, further discharging, caused the negative active material to fall out in lumps.

To continue operating the cell as before, that is, to allow it to be undercharged, overdischarged and recharged at excessive rates, the active material would, in two or three months, fill the sediment spaces in the bottom of the cell and short-circuit the plates.

If the cells were given a long charge at a low rate the negative plates would be restored to a dark gray spongy lead and the positive plates to a dark brown. The cells could afterward be charged at normal rates. Two or three more years of service could be expected. Therefore with proper care from now on the cells can be made to give ten times the service they would have given under the previous method of operation.

# What Specific Gravity Readings Mean

THE specific gravity of any substance, liquid or solid, is its weight as compared with that of an equal volume of water. Pure water, therefore, is considered to have a specific gravity of unity, or 1. One pint of water weighs approximately one pound. An equal volume of ordinary chemically pure sulphuric acid weighs 1.835 pounds and, therefore, has a specific gravity of 1.835. Ordinarily, and as a matter of convenience, these figures are read "eighteen thirty-five." Similarly, and since it is customary to carry the specific gravity figures out to three decimal places, the specific gravity of water, which is 1, is written 1.000, and spoken of as "one thousand."

### Composition of Battery Electrolyte

The electrolyte or solution used in storage batteries consists of a mixture of pure sulphuric acid and distilled or other pure water. Concentrated sulphuric acid is a heavy oily liquid, having a specific gravity, as explained above, of about 1.835. A battery will not operate if the acid is too strong, and for use in the battery the concentrated acid is, therefore, diluted with sufficient water to give a mixture or solution of suitable strength.

When pure acid and water are mixed the specific gravity of the resulting solution is naturally greater than that of water but less than that of the pure acid. The specific gravity of any such mixture is, therefore, a very accurate measure of the relative amounts of pure acid and of water present in the solution.

### Proper Strength of Electrolyte

In handling batteries of different makes, and even various types of the same make, it will be found that the same strength of solution is not recommended for all. This is sometimes puzzling to a battery owner, who does not understand why the solution in his fully charged automobile battery for example, should test 1.280 specific gravity, while the solution of his fully charged farm plant battery should test some lower value. The reason for this variation is, however, easily understood if we know what goes on in the storage battery cell when it is at work; that is, either receiving a charge or giving out a discharge current.

When a battery gives out a discharge current it does so as the result of a chemical action between the active material of the plates and the battery solution. In this chemical action some of the acid in the solution combines with the active material; that is, it is temporarily removed from the solution and taken up by the plates.

When a charging current is sent through the battery a chemical action results, which is exactly the reverse of that which occurred during discharge. The compound formed in the plates by the combination of the active material with the acid, and which is lead sulphate, is changed back by the charging current into fully charged active material and acid, the acid being returned to and mixing with the solution, which is thus restored to its full strength.

It is thus evident that there must be enough acid in the solution of any battery cell to supply what is needed to carry on the chemical action during a complete discharge, while at the same time the solution must never be too weak or too strong. Either too great an amount of acid or too little will interfere with the proper working of the battery.

If we examine various types of batteries we will find that the volume of solution in the cells as compared with the volume of the plates varies considerably. In the automobile battery, for example, the plates are contained in a close fitting rubber jar with little space around them to receive solution. The cells of farm plant batteries, on the other hand, are ordinarily

*Contributed by an Authority.*

in glass jars with considerable space around the plates and, therefore, containing a relatively large volume of solution. It is because there is a smaller volume of solution in the rubber jar battery than in the glass jar battery that the rubber jar battery solution is made stronger, that is, with a higher specific gravity. It will be found, however, that where the fully charged specific gravity of a cell is relatively high (as in an automobile battery) the specific gravity at full discharge is relatively low. In cells of all types the specific gravity at a condition of half discharge is approximately the same.

There is still another point to be considered in determining the strength of solution in any battery, and that is freezing. Pure water freezes at 32° F. A mixture of sulphuric acid and water having a specific gravity of 1.190 will not freeze solid at a temperature as low as 10° F. below zero. Fortunately, a suitable strength of solution from the point of view of proper working of the cell is also one which, except under very extreme conditions, safeguards the cell against damage from freezing.

To sum up, the battery manufacturer carefully determines the proper strength of solution for each type and size of cell he manufactures. In practical operation a slightly lower fully charged specific gravity than that fixed by the manufacturer is permissible, but the solution should never be stronger. Many batteries have been ruined through their owners reasoning that, if a little acid is a good thing, more acid is better.

### Change in Specific Gravity During Discharge and Charge

From what has been said above, it will readily be seen that when a storage battery is fully charged; that is, no acid combined with the active material of the plates, the solution will be of maximum strength, that is maximum specific gravity.

When the battery is discharged, the solution becomes weaker as part of the acid combines with the plates in producing the discharge current. This weakening of the electrolyte causes the specific gravity to fall. In the cells of a particular battery, the specific gravity may, for example, be 1.225 when the cells are fully charged and show a fall of fifty points or to a specific gravity of 1.175 during a complete discharge. This normal fall of fifty points is called the specific gravity range of the cell. It is the same in all batteries of the same type and manufacture, but varies considerably as between different types and different makes. For example, in an automobile battery, the fully charged specific gravity is ordinarily about 1.280 and the discharge specific gravity about 1.150, so that in such batteries the specific gravity range is about 130 points.

The fall in specific gravity during discharge is directly related to the amount of discharge. If a battery cell has a capacity of 100 ampere hours and a specific gravity fall of fifty points during a complete discharge, it will be found that the fall will be at the rate of one point for every two ampere hours taken out whether the discharge is just beginning or nearing its end.

Similarly, during charge the specific gravity of the solution gradually increases as the acid is driven out of the plates and returned to the solution. When the cell is completely charged, all of the acid will have been returned by the plates to the solution which will thus have had restored to it its full strength and specific gravity.

### Specific Gravity Indicates State of Charge

It is now easy to understand how, assuming that a battery is in healthy condition, the specific gravity of the solution will indicate very accurately the state of the cell with respect to charge, that is, whether the cell is fully charged, only partly charged, or completely discharged. To determine the state of charge of a cell we need only to know, first, the fully charged specific

gravity; second, the specific gravity range during a complete normal discharge; and third, the actual specific gravity of the cell whose state of charge we wish to determine.

As an example, if the fully charged specific gravity of the cell is 1.225 and the specific gravity range fifty points, and we find upon testing the solution in the cell that the specific gravity is 1.200, we may quite safely assume that the cell is in a half discharged condition. The reading of 1.200 shows that there has been a fall of twenty-five points from the fully charged specific gravity, and since twenty-five is one-half of fifty the cell is half discharged.

### Other Things That Affect Specific Gravity

If the specific gravity of the solution of the cells of a battery that has been in use is tested it will be found that all of the cells do not test exactly the same. There are a number of reasons for this. In the case of glass jar batteries particularly, there is a certain variation in the jars, some of them holding slightly more solution than others. If a battery has been in use some sediment will have been thrown down, the amount of which will not be exactly the same in all cells, and a small amount of acid will have combined with this sediment. During shipment, and even while in use, a small amount of solution is sometimes spilled, leaving the solution slightly weaker when the cells are filled with water. Although battery manufacturers carefully adjust specific gravity of cells before shipment, such adjustment cannot be made closer than a few points plus or minus.

But these variations of a few points as between the individual cells in a battery do not affect the operation of the battery and are of no importance if they are understood and allowed for in taking specific gravity readings.

### How to Use Specific Gravity Readings

The first thing to do is to find out what the specific gravity is of the solution in each cell of the battery when the battery is completely charged. All batteries should be given an occasional equalizing charge. These are usually called for in the operating instructions of the battery or plant manu-


**A hydrometer should be used for testing at regular intervals. Always hold the instrument up close to the eye level. Looking down at it is misleading.**

facturer. An equalizing charge is given by continuing a regular charge until every cell in the battery is gassing freely and evenly and successive readings of specific gravity show no further rise. When successive readings show that the solution is not becoming any stronger by reason of the continued charging, it means that all of the acid has been driven out of the plates, that is, that they are fully charged. In this connection it should be remembered that the purpose of the equalizing charge is to reduce *every* particle of sulphate in *every plate* in *every* cell. The total increase in specific gravity during the equalizing charge will ordinarily amount to only a few points, but it is the few points that are important.

Having brought the battery to a condition of full charge, and having noted the fully charged gravity of every cell, one of the cells should be selected to serve as a pilot or guide cell during subsequent operation of the battery. The reason for this is that in ordinary operation it is not necessary to test every cell, but sufficient to test one cell and be guided by that.

Reference to the instructions furnished with the battery will show the specific gravity range for the battery. It is now only necessary to read the specific gravity of the solution in the pilot cell to be able to determine at any time its condition of charge, which will be that of all of the other cells assuming them to be in healthy condition.

In this way the battery may be operated and overdischarge avoided until it comes time to give the battery another equalizing charge. At this time, and on completion of the equalizing charge, the specific gravity of all cells should again be taken, noted and compared with those of the preceding equalizing charge. If any cell or cells fails to come up as high in specific gravity as on the preceding equalizing charge it should be inspected carefully for trouble. The chief value of the specific gravity readings at the end of the equalizing charge is in calling attention to small troubles that may develop, and which, if noticed, can be readily corrected before they become serious.

## Temperature Affects Specific Gravity

Since battery solution, like most other substances, expands when heated, its specific gravity is affected by a change in temperature. Every three degrees F. change in temperature results in a change of approximately one point (.001) in specific gravity. For example, battery solution having a specific gravity of 1.200 at 70° F. will test 1.190 at 100° F. and 1.215 at 25° F. Change of temperature does not alter the actual strength of the battery solution, but simply changes its specific gravity. It is, however, evident that in order accurately to compare readings taken of a battery at one time and at one temperature with those taken at another time and another temperature, such readings should be corrected on a basis of one point for each three degrees F. The most convenient method is to correct all readings that may be taken to 70° F. as normal. If the battery temperature is below 70°, subtract one point from the actual reading for every three degrees below 70° F. If the battery temperature is above 70° F. add one point for every three degrees above 70° F.

## Taking Specific Gravity Readings

Since it is so helpful in the operation of the battery to be able to determine, at any time, the specific gravity of the solution in the cells, it is fortunate for battery owners that specific gravity tests can be easily and accurately made.

The instrument used is a special hydrometer sold for the purpose by battery manufacturers. Since many farm plant batteries are now of the sealed glass jar type, syringe hydrometers are most commonly used. Since syringe hydrometers with complete instruction for their use are readily obtainable everywhere no detailed description or explanation will be attempted here. There are, however, several practical points to which it is important to call attention.

As explained in preceding page, the charged density of the solution in batteries of various types and used for various purposes varies considerably. It follows that a syringe hydrometer designed for use in an automobile battery will not have a scale and range best adapted for use in connection with a farm plant battery in glass jars. Battery owners will, therefore, find it more satisfactory to be sure that they get the proper instrument for their use by obtaining one directly from the manufacturer of the plant or battery they are using.

To be of any value, specific gravity readings must be carefully taken and intelligently applied. It is hoped that this article, by explaining the why and wherefore of the changes in specific gravity occurring in battery cells in normal operation, may help owners to secure from their batteries the longer life and more satisfactory results which always follow intelligent care.

A word of caution with respect to putting into battery cells anything whatever except pure water: Once a battery is placed in service there is no loss of acid from the solution, and it is never necessary to add any acid to a battery. Of course, if a battery cell is upset and acid spilled, or if a jar is broken and the solution leaks away, it should be replaced. But unless acid is actually known to have been lost out of a cell none should ever be added during the entire life of the battery. The amount of acid lost in spray is so small that it may and should be neglected.

There are on the market a great many "patent" battery solutions, powders and dopes. Some of these are nothing but battery electrolyte of poor quality put up under fancy labels and sold at high prices. Others contain chemicals which attack the plates, increasing the power of the battery for a few discharges, but quickly destroying it. The battery manufacturer knows what solution is best for his batteries, so dealers are cautioned against any of these preparations and they should particularly warn their customers not to put anything whatever in the battery cells except distilled water.

# Capacity with Relation to Plate Area

IN all Faure type storage batteries, the capacity at any rate of discharge is directly proportional to the area of the positive plates of all plates of equal thickness. The thickness of plate directly affects the capacity. The thicker the plate the greater the capacity within certain limits, or within the limits at present used in the manufacture of the Faure type of plates. This is applicable only to plates used in service requiring low discharge rates, where the electrolyte has time to penetrate to the interior of the plate. At high rates of discharge—say from 100 amperes up—the capacity is directly proportional to the area, and practically independent of the plate thickness.

The breakdown of Faure type positives is due to the erosion of active material from the surface of the positive plates, consequently a thick plate will last longer than a thin plate. The following figures give some idea of the relation plate thickness bears to capacity: ⅛-inch plates at the 8-hour rate require 1.69 square inches of positive plate surface for one ampere hour capacity.

At the 72-hour rate, 1.337 square inches of positive plate surface are required for one ampere hour capacity.

7/32-inch plates at the 8-hour rate require 1.21 square inches of positive plate surface for one ampere hour capacity.

At the 72-hour rate .927 square inches of positive plate surface are required for one ampere hour capacity.

At the 5-hour rate of discharge, which is the rate adopted for starting and lighting batteries, the following gives the relation of plate thickness to capacity:

⅛-inch plates will deliver .105 amperes per square inch.
3/16-inch plates will deliver .140 amperes per square inch.
7/32-inch plates will deliver .155 amperes per square inch.
¼-inch plates will deliver 1.7 amperes per square inch. In figuring area of positive plate, only one side is used. Thus a plate 4 x 4 inches would be 16 square inches, not 32 square inches. (Contributed by Prest-O-Lite Co.)

### Another Way of Stating the Rule

The rule applicable to the matter is: twenty-five square inches of positive plate area will give 1 ampere for eight to ten hours or 1 ampere hour for two and a half square inches of the positive plate at the eight hour rate.

At the seventy-two hour intermittent rate Multiple FL batteries give 1 ampere hour capacity for each one and two-thirds square inches of positive plate area or an increase over the eight hour rate of 50 to 100 per cent.

The one-sixteenth plate should never be used for lighting batteries as their proper field is where the requirements are for very high momentary discharges. Their durability in lighting batteries is about half that of the one-eighth inch thick plates.

It has been established by laboratory experiments that upon the normal charge and discharge the surface of the positive plates are penetrated by the electrolyte to an approximate depth of one-sixteenth of an inch. Therefore, a plate one-eighth of an inch thick is required to get the full benefit of this action on both sides. However, where a high momentary discharge is wanted the surface capacity only is necessary and the thickness of the plate is of no importance.

Any plate thicker than one-eighth of an inch is simply carrying excess weight in order to maintain full capacity after the shedding process has begun. No increase in capacity is secured by using plates more than one-eighth of an inch thick, but the full capacity will be maintained over a longer period.

*Contributed by Multiple Storage Battery Co.*

# End Cells and Counter E. M. F. Cells

It will be noted that all lamps are designed to burn at a voltage slightly above and below that of the nominal voltage of the generator. In order that a lamp may last during a normal period without burning out, this voltage must not be exceeded by more than 5 per cent. in the case of 110-volt lamps and not over 10 per cent for 32-volt lamps. When a storage battery is being charged, the voltage of the cells increases, rising to a maximum value of 2½ volts per cell on charge toward the completion of the charge itself. Consequently, the generator must be capable of generating current at a maximum voltage of 40 volts or 120 volts in order to be able to charge the battery fully. But if the lamps are subjected to this increased voltage, their life is apt to be greatly shortened. On the other hand, the voltage of a storage battery falls off as it becomes discharged, dropping down to 1.75 volts per cell when nearing complete discharge and in this case, the lamps are not receiving a sufficiently high voltage to make them burn at their usual brilliance. In some of the earlier installations it was customary to employ what are known as "end cells" or "counter cells" to provide for this great variation and voltage.

The purpose of these cells is to regulate the voltage on the service line. End cells or counter cells are not required in the ordinary farm plant because as ordinarily operated the lamps are not subjected to the high charging voltage to any very considerable extent. The generator capacity does not ordinarily greatly exceed the normal charging rate for the battery. If any considerable number of lamps are turned on while the generator is running, the charging current into the battery is sufficiently reduced so that the voltage is not so far above normal as to seriously affect the life of the lamps.

Another reason for the use of end cells or counter cells is to compensate for the falling off of battery voltage during discharge. Their use is particularly necessary when the battery is discharged at fairly high rates (eight hour rate or higher) and continuously. Under such conditions the battery voltage during discharge may fall as much as fifteen per cent. If normal lamp voltage is to be maintained throughout the battery discharge it is, therefore, necessary to provide enough cells to give full lamp voltage even when the cells are discharged down to, say, 1.75 volts per cell. With the cells fully charged, therefore, or discharging at a low rate, some of the cells must be cut out, that is, end cells used, or a resistance of some kind included in the circuit. Counter cells used are used for the latter purpose.

When end cells are used, it simply means that an additional wire or wires are run from the switchboard to the battery, permitting the service line to be connected to and served from less than the full number of battery cells, an end cell switch being provided for this purpose.

Counter cells (more correctly, "counter electromotive force" cells) are simply cells with electrolyte and plates without any active material, and they are used as a resistance, being placed in series with the full battery when it is desired to cut down the voltage from the battery to the lamps. The advantage of the counter cell over an ordinary ohmic resistance is that each cell exerts a fairly constant counter electromotive force of two volts throughout a pretty wide range of current.

In many of the earlier farm lighting plants a group of three counter cells was supplied and a double pole double throw switch placed on the switchboard so that the counter cells could be placed in series with the service line when necessary. In practice, it was found that the counter cells were rarely required, and their use has been practically abandoned in these plants.

Some years ago there was considerable discussion as to whether or not counter cells or some other means of closely regulating voltage on the service line was necessary. It was feared that in the absence of something of this

kind there would be a very undesirable variation in the brilliancy of the lights and also that lamp life would be adversely affected. As stated above, practical use of the plants seems to have demonstrated pretty thoroughly that in the typical farm plant at least the extra expense and complication of counter cells or end cells is not warranted.

## Special Battery Dopes, Powders and Solutions

"WE are frequently asked by users of our batteries if there is any virtue in the special electrolytes, powders and battery solutions that are being advertised and sold under various names, and if we recommend them for use in batteries of our manufacture," writes the engineer of one of the largest battery companies when appealed to by the Editor of Farm Light and Power, for information regarding a product advertised in one of the usual fraudulently worded circulars announcing the discovery of "liquid electricity."

Here are some paragraphs typical of this class of swindles.

"We are pleased to release for general publication, the announcement of the discovery of Liquid Electricity, which has been given a trade marked name "JUCE."

Exhaustive experiments have been under way by a great many laboratories for some time to compound a preparation which put into storage batteries would assist in maintaining or recharging the battery.

Since automobiles have made the battery business such a universal business, there has been a great call for something of this kind.

In the discovery of Liquid "JUCE" Electricity, we have accomplished a process of charging a battery without the use of an electric line and without the waste of time now necessary. We charge in 10 minutes.

We have also done away with possible sulphation and have a process that stops deterioration of plates and separators and if used in good batteries will increase their life by years.

Its use is not complicated. Any one can service their own battery with it as will be noted by the enclosed circular which contains directions and prices."

Anyone with the most elementary knowledge of electricity should know that there isn't any "magic dope" which will charge a storage battery in ten minutes "without the use of an electric line." If there were, chemists and electrical engineers would have discovered it without the assistance of the bunco fraternity whose cardinal principle is "There's a sucker born every minute." Far from being beneficial to a battery, the use of any of these wonder-working solutions is apt to mean a stiff bill for repairs or replacements. If you get any circulars of this kind, don't light the fire with them—not right away. Stick them in your pocket and warn users of your plants not to be taken in by these swindlers. Tell them to continue putting nothing but distilled water in their batteries and you'll be responsible for the results.

Realizing the great amount of damage that can be done to storage batteries by the use of these dopes, apart from the fact that the buyer is paying two or three dollars a pound for a common salt, such as sodium sulphate, that costs the swindler a few cents a pound, Farm Light and Power asked a battery manufacturer for analysis of the various dopes put out from time to time. Here is the answer; it should be carefully read by every dealer and the advice given as carefully followed.

### What Analysis of These Dopes Reveals

"In order to be able to answer these inquiries, we have been at some pains to obtain samples of a large number of these battery solutions, powders, and pills for analysis and to permit us to determine, by actual trial, if they have the merits claimed for them. We have recently analyzed a sample of 'Juce' and find that it is typical of the 'freak' electrolytes described above, of which upward of twenty have come to our attention.

"We can state very positively, with respect to all of those that we have tested, that we have yet to find any that have a really beneficial effect. On the contrary, we have found many the effect of which on batteries is positively injurious.

"Some of these special battery solutions consist of electrolyte with sodium sulphate added in amounts running all the way from a fraction of one per cent. up to 16 or more per cent. Still others consist of electrolyte with a percentage of sodium bichromate or sodium phosphate. Organic matter is also sometimes added. Powders and pills are apt to be sodium or magnesium sulphate, or the like in powder or tablet form, sometimes with a filler to give bulk. The jelly electrolytes are electrolyte made up with the addition of sodium silicate to form a jelly and sometimes with the addition of some fibrous material.

"With respect to those consisting of electrolyte with a percentage of sodium sulphate, the idea of adding a small percentage of sodium sulphate to battery electrolyte dates back twenty-five or thirty years. A small amount of sodium sulphate is harmless. With the larger percentage found in some of these patent solutions, the battery capacity and voltage are sensibly reduced. The idea that sodium sulphate is beneficial to batteries, and especially that it is helpful in reducing sulphated plates, is an old superstition in the battery business.

**Buy the Stuff Yourself If You Must**

"As stated above, a small amount, say, less than one per cent. by weight, of pure sodium sulphate does no harm, but if any battery owner wishes to use it he might better go to a reputable dealer and obtain the pure chemical at a cost of a few cents per pound rather than to purchase it at a rate of several dollars per pound under some fancy name.

"Sodium or potassium bichromate and similar salts are distinctly injurious. It is further true that a number of these patent solutions and powders are made up from impure materials containing high percentages of iron, nitric acid and other impurities injurious to batteries.

"Jelly electrolytes made of pure sodium silicate and pure sulphuric acid electrolyte have a somewhat limited field of usefulness in storage batteries. Such jelly electrolytes have been used in batteries for at least thirty years. In pocket batteries or the like, where good voltage characteristics and capacity are not of the first importance, and the use of fluid electrolyte is objectionable, the jelly electrolyte can sometimes be used to advantage. Any battery owner believing that he has a legitimate use for jelly electrolyte can make it up for himself in quantity at slight expense and can obtain the formula and complete directions from most any of the larger storage battery manufacturers.

"We have advised distributors of our product that in our opinion they are entirely safe in advising battery users that none of these solutions, powders or pills have any real merit. If strong solution is put into a discharged battery and a somewhat superficial test made, it may be made to appear that the battery has been benefited. Quite the contrary is true. In view of the foregoing you will readily understand why we earnestly recommend that owners of valuable batteries steer clear of these patent preparations."

## BATTERY RECORD SHEET

| | | PILOT CELL READINGS (PILOT CELL IS # ) | | | | | | INDIVIDUAL CELL READINGS (Specific Gravity) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | START OF CHARGE | | | FINISH OF CHARGE | | | | DATE | | | |
| DATE | * NOTES | TIME | SPECIFIC GRAVITY | TEMPERATURE | TIME | SPECIFIC GRAVITY | TEMPERATURE | CELL # | | | | |
| | | | | | | | | 1 | | | | |
| | | | | | | | | 2 | | | | |
| | | | | | | | | 3 | | | | |
| | | | | | | | | 4 | | | | |
| | | | | | | | | 5 | | | | |
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* Mark X on the dates water is added.
Mark ✓ on the dates equalizing charge is given.

**Simple form of battery record suggested by a leading battery manufacturer. Unless a record is kept of the attention given a battery and the dates, it will be difficult to keep it in good condition.**

# Battery Record Sheet

The record shown has been prepared with the idea of making it just as simple and as easy to keep as possible, and yet be of value in checking the operation and condition of the battery. The most ready application perhaps would be to rule a cardboard and hang it on the wall near the battery so that entries could be made very readily. Another method would be to use a blank book and have the pages ruled according to the sample.

The number of "Pilot Cell Readings" which may be entered on one sheet or card will, of course, depend upon the length of the card to a large extent. The relation between the number of "Pilot Cell Readings" spaces and the number of "date" columns under "Individual Cell Readings" will depend upon the frequency with which the battery is charged. This will vary considerably with different plants, but a ratio of one column to every ten spaces is as good as any.

### Function of the Pilot Cell

The "Pilot Cell" may be any cell, but it should always be kept the same. The pilot cell does not differ from the others. It is simply chosen to act as the pilot or indicator for the entire battery. The level of solution in it should be kept within a quarter inch each way of the normal as the height of solution affects the specific gravity reading. If the cells are in glass jars a good scheme is to paint a line on the outside of the glass about one-half inch above the tops of the plates and keep the level of solution within a quarter inch of this line.

The number of the pilot cell should always be recorded as this gives the connection between the regular charges and the "equalizing" charges. If the cells are not numbered, the cell at the positive end of the battery may be called number one and the electric circuit followed. The system of numbering is arbitrary, but it is necessary that the cells always be called by the same number.

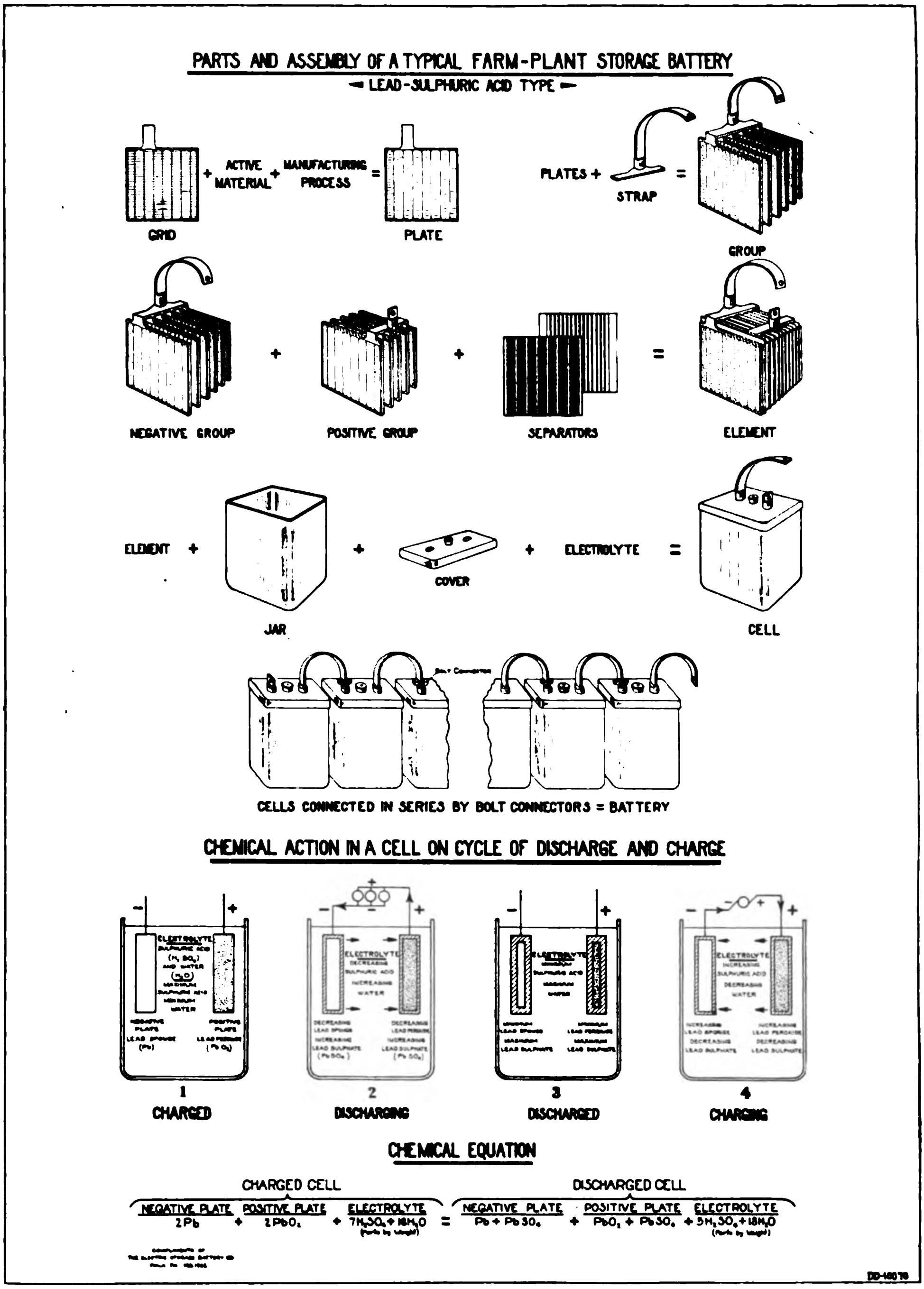
Every time the battery is given a charge, the pilot cell readings should be recorded, together with the time, at both the beginning and end of charge. Equalizing charges are extra long charges given periodically in accordance with the battery manufacturer's instructions. Whenever one of these is given, it should be indicated by marking an "X" in the column headed "Notes."

Whenever water is added, a check mark (√) should be recorded in the "Notes" column and the date entered.

### Test All Cells Three or Four Times a Year

Individual cell readings of specific gravity should be recorded three or four times a year at the end of an equalizing charge. It is important that the readings be taken at the **end** of this charge. Comparison of successive sets will show if there are any weak cells before they are damaged. Particular care should be taken to also record the pilot cell readings at the beginning and end of this charge.

Specific gravity readings are taken with an instrument called a hydrometer or a hydrometer syringe. A hydrometer is a glass float and is used in cells where there is room for it to float unobstructed. For cells where this cannot be done the float is enclosed in a glass barrel with a rubber bulb at the top end and a tube at the bottom. Solution is drawn from the cell until the hydrometer floats and is then returned to the same cell. The complete instrument is called a hydrometer syringe.




**This shows the progressive assembly of a storage battery, illustrating each stage in its manufacture. It also shows the chemical action and reaction during a cycle of discharging and charging. Specially drawn for the Farm Light and Power Year Book.**

# Elementary Electrical Principles

TO acquire a good practical working knowledge of electricity, it is essential not merely to find out *how* things are done, either by watching the other fellow do them, or by studying "pictures in a book," but also to learn *why* certain things are done and *why* they are carried out in just such a way. In other words, the man whose knowledge is based upon theory and principles applies knowingly the cause to produce the effect and is certain that the desired effect will be produced.

If we want to know what is wrong with an electric motor, it is essential that we should know what makes an electric motor operate when everything is right. In the same way, it would be groping in the dark to attempt to investigate the reasons for the failure of a dynamo to generate current, or a storage battery to give up its charge, if we had no knowledge of why a dynamo, when run by an outside source of energy, normally produces a current, or why an accumulator literally "gives back" what has been put into it when its circuit is closed after charging.

### The Electric Circuit

The amount of electricity that any given object possesses at a given moment depends upon its capacity (the electrical meaning of which is given later) and the conditions of surrounding objects. For example, a room will hold a certain amount of air; if it is uninfluenced by other conditions, we know that the room is full of air at an approximate atmospheric pressure of 15 pounds to the square inch (the usual pressure at sea level). The room may be considered in a normal "state of charge."

There is nothing that differentiates the air in this room from that of the room adjoining. It is perfectly quiet and nothing is disturbing it; there is no tendency for it to move. If, however, all the openings of the room are tightly closed with the exception of a duct for the admission of more air under the impulse of a powerful compressor, in a very short time there will be a marked difference between the air in this room and the air in the other rooms. Instead of the normal atmospheric pressure of 15 pounds per square inch, there will be a pressure against all parts of the room—floor, walls, and ceiling—of 50, 60, or 100 pounds, according to the length of time the compressor has been working. Thus there will be a great deal more air in the one room than in its neighbors. If it were electricity instead of air, the room would be said to be highly charged.

The air in this room, on account of the pressure which it is under, is constantly seeking an outlet, and it will gradually leak out through various small openings, probably without its escape being noticed. The same conditions obtain when a body becomes electrified beyond its capacity to hold a charge—the charge of electricity will leak away without giving any indication of its passing. Turning again to the room containing the compressed air, if a door or window of that room is opened suddenly, the pressure is immediately released through that opening and anyone standing in front of it would say that a strong current of air blew out. In the case of electricity, if any easy path of escape is provided, the entire charge will rush away from the body, and there is then said to be a current of electricity "flowing" from this point of escape to whatever other object equalizes the pressure by becoming charged. An electric current is accordingly electricity in motion; it is simply said to flow. But to cause it to do so there must be pressure. The electrical term for this pressure is ***potential*** or *voltage*.

### Electrical Pressure

Every day in the year the earth transmits a greater or less proportion of its electrical charge to the atmosphere, or receives a charge from the latter, but unless the conditions are favorable there is no visible indication of this

*difference of potential* as it is termed. This difference of potential, or electrical pressure between two points is what causes a current to flow. Given a hot day in summer, however, when the air is heavily charged with moisture and low cumuli, or rain-charged clouds form in great masses, then the electrical charges from the earth and the air accumulate in these great banks of dense water vapor instead of passing up to the higher regions of the atmosphere. When the charge exceeds the capacity of the clouds, and the electrical pressure, or difference of potential, between two neighboring clouds or between a cloud and the earth becomes very great, we have the familiar phenomenon of lightning, the electricity escaping in a several-mile-long flash instead of by means of the little spark with its snap as it passes from one object to another under similar conditions.

### Resistance and Its Measurement

Electricity can be expressed as a quantity and can be subjected to pressure. The unit of electrical pressure is the *volt*; the unit of current is the *ampere*. Resuming the simile previously given, 50 cubic feet of air per minute forced into a room under 100 pounds pressure may be likened to a current of 50 amperes at 100 volts. And, just as the opening allowed determines the rate at which air will escape, so the electrical outlet influences in the same manner the current that will flow. From this it is evident that there is another factor to be considered. This is resistance.

If a half-inch hole is bored in the door of the room, the air will escape at a pressure of 100 pounds to the square inch, but only a few cubic feet per minute can pass through the orifice. If a very fine wire is used to tap the given charge of 50 amperes at 100 volts, the current will have a potential of 100 volts, but very few amperes will pass through the fine wire. If the pressure back of the air is increased, however, more air will be forced through the small opening in the same time; and if there is a greater potential back of the electrical current, more current will be passed through the fine wire. Thus the factors of electrical quantity, pressure, and flow are all related and are all dependent on the factor of resistance. The unit of resistance is the *ohm*.

### Ohm's Law

From this interrelation has been deduced what is known as Ohm's law, usually expressed as $I = \frac{E}{R}$, or current equals voltage divided by resistance, $E$ denoting the electromotive force, which is only another term for voltage or potential—the electrical moving force back of the current $I$. The law is stated in three ways:

1. The current flowing in any circuit (*amperage*) is equal to the *voltage divided by* the *resistance* (*ohms*).

2. The *voltage* is equal to the current (*amperage*) *multiplied by* the *resistance* (*ohms*).

3. The *resistance* is equal to the *voltage divided by* the *amperage*.

The formula for Ohm's law may be transposed to find any one of the three factors that may be unknown.

The amount of resistance in any circuit can be either measured or figured, but the actual measurement of resistance is a laboratory operation requiring delicate and expensive instruments. To figure the resistance in any circuit, it is only necessary to know the *voltage* and the *amperage* which can easily be obtained by means of a voltmeter and an ammeter.

### Unit of Measurement of Resistance

The unit by which resistance is measured is called on *Ohm*. A wire or circuit has a resistance of *one ohm* when it requires a pressure of *one volt* to

force current through it at the rate of *one ampere.* A few examples will serve to illustrate Ohm's law:

If a circuit has a resistance of 10 ohms, how many amperes will flow at a pressure of 32 volts? According to Ohm's law,

Current (amperes) $= \dfrac{\text{voltage}}{\text{resistance ohms}}$. Therefore, the amperage $= \dfrac{32}{10}$, or 3.2 amperes. Using the above example with 20 ohms resistance instead of 10 ohms—

The amperage $= \dfrac{32}{20}$, or 1.6 amperes.

Hence, *if the voltage is constant,* the *amperage* will *decrease* in the same proportion that the *resistance is increased.*

If a circuit has a resistance of 10 ohms, what voltage will be required to cause current to flow at the rate of 3.2 amperes?

According to the second way of stating Ohm's law,

Voltage=current (amperes)×resistance (ohms). Therefore, the voltage= 3.2×10 or 32 volts.

Using the above example with 11 amperes instead of 3.2 amperes,

The voltage=11×10 or 110 volts.

Hence, *if the resistance is constant,* the *amperage* will *increase* in the same proportion as the *voltage is increased.*

If a circuit has a current of 5 amperes flowing at a potential of 32 volts, what is the resistance of the circuit? According to the third form of Ohm's law,

The resistance (ohms) $= \dfrac{\text{voltage}}{\text{amperage}}$. Therefore, the resistance $= \dfrac{32}{5}$, or 6.4 ohms.

Using the above example with 110 volts instead of 32 volts, the resistance $= \dfrac{110}{5}$, or 22 ohms. Hence, *if the amperage is to be maintained constant* in a circuit the *resistance* must be *increased or decreased* in the same proportion that the voltage is *increased or decreased.*

Ohm's law is absolutely fundamental in all things pertaining to electrical operation, and the man who wants to make his knowledge of the greatest practical use will do well to familiarize himself with it.

### Electric Power

To go back to the simile of air under pressure, the energy released by the lowering of this pressure may be made to perform useful work, such as driving a compressed-air drill, running a small air motor, or the like. So with the electric circuit, the drop from a higher to a lower potential which causes a current to flow, is the source of power. Electric power is the product of the amperage or current times the voltage. The power unit is the *watt,* equivalent to one ampere at a potential of one volt. There are 746 watts in a horsepower.

Electric power is figured by the kilowatt, or one thousand watts, and the charge is based upon the length of time for which this amount of energy is employed, as for example a "kilowatt-hour."

The power equivalent is expressed as $P = I \times E$, current multiplied by electromotive force (potential), and as in the case of Ohm's law, with any two of the factors given, the third may be readily determined.

The power in a circuit depends upon the pressure, or voltage, and the rate of flow, or amperage. As mentioned in connection with resistance, it is only necessary to find the voltage by means of a voltmeter, the rate of flow by means of an ammeter, and multiply the two. For example, if current is flowing at the rate of 2 amperes at 32 volts, the power is 2×32, or 64 watts. To figure the amount of current required by a lamp, say a 40-watt lamp on a 32-

volt system, divide watts by volts. Thus, 40 ÷ 32 = 1¼ amperes. To find the wattage of a 32-volt lamp that uses 2 amperes, multiplying 32 by 2 gives 64 watts.

One thousand watts, or 1 KW. is equivalent to approximately 1⅓ horsepower, so that 1 horsepower is about ¾ kw., which explains why a 3 horsepower gasoline engine is required to drive a 1½ kw. generator. The engine absorbs some of its power in overcoming its own friction and must also be capable of carrying a reasonable overload.

### Conductors of Electricity

To lead steam or air under pressure from a boiler or compressed-air reservoir to the point at which it is to be utilized as energy, it is desirable to use a conductor that will not waste too much of this energy in useless friction. That is, the conductor must be of ample size in proportion to the volume to be conveyed, smooth in bore, and free from sharp turns or bends. The transmission of electrical energy involves some of the same factors. While neither the smoothness of the bore nor the presence of bends and turns has any effect, they have their counterpart in the conductivity of the material of which the wire is made, and the size of the wire in proportion to the amount of current to be carried.

### Resistance of Materials

Materials differ greatly in the amount of resistance they offer to the current. Silver in its pure state heads the list in the table of relative conductivities, and it is accordingly said to possess a relative resistance of one, or unity; the resistance of every other material may be expressed by a number which represents the resistance of that particular substance as compared with pure silver. Copper, which is second on the list, is almost universally employed. Pure copper is very soft and is lacking in tensile strength; it is therefore alloyed and also hardened in the drawing process, both increasing its resistance slighty over the factor usually accorded it in the standard table of specific conductivities of materials. In this table, German silver (an alloy containing no silver and having few of its properties), cast iron, steel, carbon, and similar substances will be found well down toward the end. They are known as "high-resistance" conductors and are used where resistance to the current is desirable.

But ability to conduct a given amount of current without undue loss through resistance depends upon the size and the length of the conductor quite as much as upon the material. If a steel rail is only one-thirtieth as good a conductor as a copper cable, it will require a cross-section of steel thirty times as great as that of a copper cable in order to conduct the current with the same ease—that is, to make a conductor of equal resistance. An illustration of this may be seen in the overhead copper wire of the usual trolley system. This wire of about one-half inch diameter forms one of the conductors while the two steel rails form the "return." A similar example may be found in what is known as the single wire system of installation for an electric starter in automobiles. A single copper cable conducts the current from the battery to the starting motor, while the steel frame of the automobile is the return side of the circuit, or vice versa.

### Voltage Drop and Correct Wire Sizes

The resistance of a circuit varies inversely as the size of the conductor —the larger the cross-section of a conductor, the less its resistance—and increases directly as its length, besides depending upon the specific resistance of the material. The specific resistance of the metals constituting electrical circuits: copper 1.13, varying more or less with its hardness; aluminum 2.0; soft iron 7.40; and hard steel 21.0. Thus, 9.35 feet of No. 30 copper wire are required for a resistance of one ohm, while only 5.9 inches of hard steel

wire of the same gage are required to present the same amount of resistance to the current. If the length of the conductor is doubled, its resistance is doubled, which accounts for the placing of the storage battery as close as possible to the center of distribution. If two wires are of the same length but one has a cross-section three times that of the other, the resistance of the former is but one-third that of the latter. If a circuit is made up of several wires of different sizes joined in series with one another, the total resistance will be the sum of the resistance of the various parts.

In addition to being affected by the cross-section and the length, the resistance is also influenced by the temperature. All metals increase in resistance with an increase in temperature, that of copper increasing approximately .22 per cent. per degree Fahrenheit.

It is consequently necessary to employ wires of proper size to carry the amount of current required by the apparatus in circuit motors, lamps, etc., without undue heating, which would cut down the amount of current flowing. For the same reason it is also desirable to make the circuits as short as practicable, since in addition to cutting down the current, the resistance also cuts down the effective voltage. That is, there is a fall of potential, or drop in voltage, between the source of current supply and the apparatus utilizing it, due to the resistance of the conductors between them. This voltage drop is further increased by joints in the wiring and by switches. It is apparent that the lower the voltage of the source of supply, the more important it becomes to minimize the loss, or voltage drop, in the various circuits. When necessary to extend a circuit for any reason, wire of the same diameter and character of insulation as that forming the original circuit must be employed, and the joints should be as few as possible, all mechanically tight, and well soldered.

### Non-Conductors and Insulators

In going down through a table of specific conductivities of various materials, the vanishing point is reached with those that cease to be conductors at all. Such materials are known as non-conductors or insulators, and some substances vary in the degree of insulation they afford quite as much as other materials do in their ability to conduct a current. Glass, rubber, shellac, oil, paraffin wax, wood, and fabrics are all good insulators when perfectly dry. Distilled water has such a high resistance as to be almost an insulator, but in its natural state water contains alkaline salts or other impurities that make it a conductor. Consequently, when any otherwise good insulating substance is wet, the current is likely to leak across the wet surface of the insulator. This is particularly the case with a current of high potential, or high tension, and explains why it is of the greatest importance to keep all parts of the secondary side of the ignition system of the engine perfectly dry. The potential which causes the current to arc across the gap of the spark plug is so high that it will leak across even slightly damp surfaces, such as the porcelains of the plugs. This leakage is often visible, especially in the dark, and it may also be detected by placing the bare hand on the porcelain.

Just as the amount of current to be carried determines the size of the conductor to be employed, so the potential or pressure under which this current is transmitted determines the amount of insulation that will be necessary. The latter is also affected, however, by mechanical reasons, for example, by the liability of the conductor to chafing or abrasion. The best grades of copper cable employed for ignition systems are stranded to make them flexible. The stranded cable is then tinned to prevent corrosion due to the sulphur in the insulation, after which it is covered with a soft-rubber compound of a thickness dependent upon the purpose for which the wire is intended. For high-tension ignition wire this rubber covering is about three-sixteenths inch

thick. This covering is vulcanized and is then further protected by braided linen, or silk-cotton thread which is made waterproof by being impregnated with shellac or some other insulating compound.

For low voltage wiring such as required for house and barn wiring and the outside lines, the insulation required will depend upon the service to which the wire is put, but in any case a wire should never be used simply because its insulation is cheaper. Underwriters' standard double braid should be used for inside wiring and "weatherproof" for all outdoor lines. Never attempt to cut costs by using wire that is too small or not insulated properly, it is quite the reverse of saving money, it is wasting it and running the risk of fire.

### Types of Electric Circuits

When air under high pressure escapes from its container, it simply mingles with the atmosphere, and as soon as the difference in pressure is equalized there is no distinction between it and air in general. But to equalize a difference in potential of an electric current there must be a conducting path between the points of high and low potential. This is termed a circuit. Current to operate trolley cars is fed to the motors of the car from the overhead wire and returns through the tracks to the generators at the power-house. This is known as a *ground-return* circuit.

Both the primary and secondary sides of a high tension ignition system are also grounded circuits.

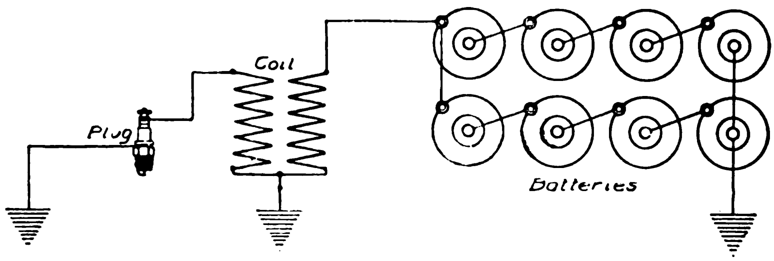
### Series Circuit

The connections between a storage battery, switch, and motor, or lamp, comprise the simplest form of circuit, in which the motor is said to be in series with the battery, and the cells of the battery are in series with one another. This is termed a series circuit and a break in it at any point opens the entire circuit.

To make clear the distinction between this and other forms of circuit, it must be borne in mind that, in equalizing a potential difference, electric current flows from the positive or plus side of the source of supply, whether a battery or generator, to the negative or minus side (plus and minus being arbitrary signs employed to distinguish the positive and negative sides of a circuit or of an instrument). The current is said to flow out on the positive side of the circuit and to return on the negative side. In the case of a series circuit as described, the current flows through each piece of apparatus in turn; each receives all the current in the circuit at a potential proportioned to the resistance of the apparatus in question. For example, in the simple circuit referred to above the motor receives current from the storage battery at its full voltage, less the drop in voltage due to the resistance of the circuit and its own resistance. If there were two motors instead of one in the circuit, both in series, both would receive all the current but at only half the voltage.

### Multiple or Shunt Circuit

As opposed to this, in a multiple circuit, in which every piece of apparatus is connected to both sides of the circuit "in parallel," each piece of apparatus in the circuit receives current at the same voltage but draws from the circuit the current determined by its resistance. The failure or withdrawal of any one or more instruments in a multiple or parallel circuit has no effect on those remaining. Lighting circuits are an example of this. Each lamp is designed to burn to its maximum illumination at 32 or 110 volts, but the 100-watt lights take more current than the 25-watt lights, owing to the difference in the size and resistance of their filaments. Removing any one of the bulbs has no effect on any of the others, because all are in parallel,




**Dry cells in series-multiple circuit for ignition. The plug and coil are in series as are also the individual cells of the battery, the two groups of four cells each being in multiple. This is also an instance of a ground-return circuit.**

### Series-Multiple Circuit

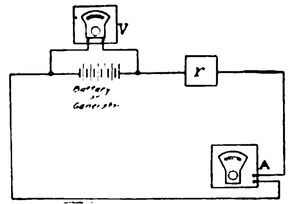
A combination of the two forms or circuits is sometimes necessary to accommodate different devices designed for varying voltages. For example, two groups of dry cells are connected in series so that the ignition coil receives current at 6 volts, but has twice the capacity to draw upon. Such a combination is known as a series-parallel or series-multiple circuit and is more or less commonly used for connecting dry cells for ignition use with stationary engines. With farm light and power plants a magneto or the storage battery supplies the current.

Circuits may also be in parallel, that is, practically a circuit on a circuit. The method of connecting up the voltmeter is an instance of this, a wire being led from each side of the main circuit to the instrument. The instrument is then said to be *in shunt*, and the amount of current that is diverted to it is entirely dependent on the resistance. As a voltmeter is wound to a high resistance, it is designed to take very little current for its operation. The ammeter, on the other hand, is intended to indicate the entire current output of the generator on charge or discharge, and is accordingly connected in series so that all the current passes through it.

### Short-Circuits and Grounds

The previous paragraphs have made clear the necessity for having a complete path or circuit for the current in order that its power may be utilized. There must be two connecting wires or a wire on one side and a ground return on the other (grounded circuit). If, instead of passing through the apparatus, such as a motor, the current finds an easier path through an abrasion in the insulation of the cable and some metal part against which that touches, it is said to be *short-circuited*. A case such as that cited, where a stripped cable touches a metal part, so that the current completes the circuit without passing through the motor, is usually termed a *ground*. This should not be confused with the ground return previously mentioned as a characteristic of ignition circuits. It is a ground return but not an intentional one. It is also true that a ground of this type is a short-circuit, but it does not necessarily follow from this that all short-circuits are grounds, as short-circuits may occur from any other causes—for instance, where two wires touch at uninsulated points or where stray metal makes contact with connections, etc.

**Another type of series-multiple circuit. The ammeter A is in series with the battery and the load r, while the voltmeter V is in multiple with the battery or generator. This circuit is commonly found on switchboards.**



## Size of Conductors

The influence of the factor of resistance makes plain the reason for using wires of different sizes for various circuits. If an ample flow of compressed air is desired for power purposes, a liberal outlet must be provided, while if only a small spray is required, as for cleaning purposes, a small-bore tube will suffice. If we try to employ the small-tube line for power purposes, we shall not gain the desired result because its resistance is so great that it will not permit a sufficient flow of air.

Whether it is mechanical or electrical in its nature, the power necessary to overcome resistance is liberated in the form of heat. Mechanical resistance is friction and its presence between moving bodies always generates heat. Electrical resistance may, for the purpose of illustration, be termed internal or molecular friction, and it also results in heat. The extent of the rise in temperature of a conductor or wire, depends entirely upon the proportion that its size and, consequently, its current-carrying ability bear to the amount of current that is sent through it. Roughly speaking, if a wire is three-fourths the size it should be to carry the starting current, it will become uncomfortably warm to the hand after it has been carrying a load for half an hour or more. If it is only one-half the size it should be, continuous operation under load will burn off most of the insulation. Further reducing its size would cause the wire to become so hot as to set fire to the insulation the moment the current was turned on, and any great decrease in diameter would result in the immediate fusing of the wire itself. The wire would literally "burn up" and in a flash. See accompanying tables for sizes and carrying capacities.

**Table American Wire Gage (B. & S.)**

| No. | Diameter in Mils | Diameter in Mm. | Circular Mils | Ohms per 1000 Ft. | No. | Diameter in Mils | Diameter in Mm. | Circular Mils | Ohms per 1000 Ft. |
|---|---|---|---|---|---|---|---|---|---|
| 0000 | 460.00 | 11.684 | 211600.0 | .051 | 19 | 35.89 | .912 | 1288.0 | 8.617 |
| 000 | 409.64 | 10.405 | 167805.0 | .064 | 20 | 31.96 | .812 | 1021.5 | 10.566 |
| 00 | 364.80 | 9.266 | 133079.4 | .081 | 21 | 28.46 | .723 | 810.1 | 13.323 |
| 0 | 324.95 | 8.254 | 105592.5 | .102 | 22 | 25.35 | .644 | 642.7 | 16.799 |
| 1 | 289.30 | 7.348 | 83694.2 | .129 | 23 | 22.57 | .573 | 509.5 | 21.185 |
| 2 | 257.63 | 6.544 | 66373.0 | .163 | 24 | 20.10 | .511 | 404.0 | 26.713 |
| 3 | 229.42 | 5.827 | 52634.0 | .205 | 25 | 17.90 | .455 | 320.4 | 33.684 |
| 4 | 204.31 | 5.189 | 41742.0 | .259 | 26 | 15.94 | .405 | 254.0 | 42.477 |
| 5 | 181.94 | 4.621 | 33102.0 | .326 | 27 | 14.19 | .361 | 201.5 | 53.563 |
| 6 | 162.02 | 4.115 | 26250.5 | .411 | 28 | 12.64 | .321 | 159.8 | 67.542 |
| 7 | 144.28 | 3.665 | 20816.0 | .519 | 29 | 11.26 | .286 | 126.7 | 85.170 |
| 8 | 128.49 | 3.264 | 16509.0 | .654 | 30 | 10.03 | .255 | 100.5 | 107.391 |
| 9 | 114.43 | 2.907 | 13094.0 | .824 | 31 | 8.93 | .277 | 79.7 | 135.402 |
| 10 | 101.89 | 2.588 | 10381.0 | 1.040 | 32 | 7.95 | .202 | 63.2 | 170.765 |
| 11 | 90.74 | 2.305 | 8234.0 | 1.311 | 33 | 7.08 | .108 | 50.1 | 215.312 |
| 12 | 80.81 | 2.053 | 6529.9 | 1.653 | 34 | 6.30 | .160 | 39.7 | 271.583 |
| 13 | 71.96 | 1.828 | 5178.4 | 2.084 | 35 | 5.61 | .143 | 31.5 | 342.433 |
| 14 | 64.08 | 1.628 | 4106.8 | 2.628 | 36 | 5.00 | .127 | 25.0 | 431.712 |
| 15 | 57.07 | 1.450 | 3256.7 | 3.314 | 37 | 4.45 | .113 | 19.8 | 544.287 |
| 16 | 50.82 | 1.291 | 2582.9 | 4.179 | 38 | 3.96 | .101 | 15.7 | 686.511 |
| 17 | 45.26 | 1.150 | 2048.2 | 5.269 | 39 | 3.53 | .090 | 12.5 | 865.046 |
| 18 | 40.30 | 1.024 | 1624.1 | 6.645 | 40 | 3.14 | .080 | 9.9 | 1091.865 |

## Heating Effect of Current

The amount of heat that a given current will produce in passing through a conductor of a certain size is expressed by Joule's law: The number of heat units developed in a conductor is proportionate to its resistance, to the square of the current, and to the time that the current lasts.

The heat generated, therefore, increases in direct proportion to the resistance. For example, if the wires in a circuit be replaced by others half the size, the resistance will be doubled and the heat generated will increase in the same proportion, the current remaining the same in both instances. Increasing the current, however, adds to the amount of heat generated, as

the square of the increase. Thus, if with the original wires the amount of current carried is doubled, owing to adding motors and lights, the volume of heat generated will increase four-fold. The amount of heat generated also increases in direct proportion to the time that the current lasts. It will be easy to realize from this why abnormal conditions may quickly bring the heating effect of the current to a point where the insulation of the wires, or even the wires themselves, may be endangered. For instance, in the case of an overloaded motor on a circuit already carrying its full rated load there is a direct increase in the heating effect, due to the time that the current is passing and a four-fold increase for the additional current necessary.

**Carrying Capacity of Wires**

| B. & S. Gage | Circular Mils | Rubber Insulation Amperes | Other Insulation Amperes |
|---|---|---|---|
| 18 | 1,624 | 3 | 5 |
| 16 | 2,583 | 6 | 10 |
| 14 | 4,107 | 15 | 20 |
| 12 | 6,530 | 20 | 25 |
| 10 | 10,380 | 25 | 30 |
| 8 | 16,510 | 35 | 50 |
| 6 | 26,250 | 50 | 70 |
| 5 | 33,100 | 55 | 80 |
| 4 | 41,740 | 70 | 90 |
| 3 | 52,630 | 80 | 100 |
| 2 | 66,370 | 90 | 125 |
| 1 | 83,690 | 100 | 150 |
| 0 | 105,500 | 125 | 200 |
| 00 | 133,100 | 150 | 225 |
| 000 | 167,800 | 175 | 275 |
| 0000 | 211,600 | 225 | 325 |

## Heating Effect on Lamps and Fuses

The heating effect of the current is not always detrimental, as it is taken advantage of in many ways. Two of the commonest of these are the incandescent lamp and the fuse. In the case of the former, the increase in heat with an increase in resistance is mainly depended upon, the filament being made of such a size that a given amount of current at a certain voltage will just bring it to incandescence. For this reason an increase in the current, or voltage, will burn the filament and destroy the lamp. The fact that the heating effect increases as the square of the current is taken advantage of in the design of fuses which are made of soft alloys that will melt at comparatively low temperatures. Resistance is also a factor in the fuse, as in cutting down the cross-section of the fusible wire the resistance is increased, while the current-carrying capacity of the wire is decreased. The cross-section, or diameter, of the fuse is gaged to carry the amount of current that is a safe load for the circuit and the apparatus in it plus a reasonable factor of safety to prevent the fuse from burning out, with a small percentage of increase that would do no damage. For example, a 10-ampere fuse, such as is used on most house lighting circuits, would seldom burn out with an increase in the current to 12 amperes or even to 15 amperes for very short periods, as the time element is also important. Some other applications of the heating effect are the electric iron, toasters, heaters, electric soldering coppers, cooking utensils and the like.

## Chemical Effect of Current

The passage of an electric current likewise has a chemical effect depending upon the nature of the conductor. This may take various forms, such as the conversion of one chemical compound into another, as in the case of the storage battery; the decomposition of water into hydrogen and oxygen; the deposition of metals, as in electroplating; or the decomposition of metals, as in electrolysis.

### How to Figure Proper Wire Sizes

On a 32-volt system it is not desirable to have a greater drop than two volts drop for distances up to half a mile, but it is not at all advisable to transmit current at 32 volts over 1,000 feet. On a 110-volt system, it is good practice not to exceed five volts drop for distances up to half a mile. Thus, the voltage drop, amount of current or amperage, and the distance in feet over which the current has to be carried, determine the correct size of wire.

The rule is as follows:

$$\frac{\text{Amperes} \times \text{distance in feet one way} \times 22}{\text{Volts drop}} = \text{Area of wire in circular mils.}$$

Hence, multiply the load in amperes by the distance in feet, and then multiply again by 22. Dividing the result by the allowable voltage drop gives the number of circular mils required. The corresponding size of wire is then found by referring to the wire table.

The number 22 is the "constant" or coefficient for copper, and is used in all cases when figuring on copper wire. For any other material than copper, a different constant would have to be used.

Example:

What size wire should be used to transmit 10 amperes a distance of 250 feet, allowing for a 2-volt drop?

Using the above rule:

$$\frac{10 \text{ amperes} \times 250 \text{ feet} \times 22}{2 \text{ volts drop}} = 27{,}500 \text{ circular mils.}$$

Referring to the wire size table, 27,500 circular mils comes between No. 5 wire and No. 6 wire. It would be necessary, therefore, to use No. 5 wire. If No. 6 wire were used the voltage drop would be slightly greater than two volts, but in this case, the size given is so close to that of No. 6 that there would be no perceptible difference in the lights, though No. 5 would be better.

The method of figuring wire sizes already given applies only when buildings are to be supplied separately with current. That is, when each building is on its own line. When two or more buildings are supplied with current from a common "feeder," the wire sizes will have to be figured to carry the load of two or three at the same time. For example, three buildings situated in a straight line away from the plant, the buildings being distant 100 feet from each other, assuming that the buildings will use 5, 5 and 10 amperes respectively, and that all of the loads may be required at the same time.

First, take the most distant, or third building. Load five amperes, distance 300 feet.

$$\text{Then } \frac{5 \times 300 \times 22}{2} = 16{,}500 \text{ circular mils} = \text{No. 8 wire.}$$

This would be the size necessary to carry five amperes to the building 300 feet from the plant.

Consider next, the second building in the same manner, the load being five amperes and the distance 200 feet.

$$\text{Then } \frac{5 \times 200 \times 22}{2} = 11{,}000 \text{ circular mils.}$$

This would represent the size of wire necessary to carry five amperes to the building 200 feet away from the plant; but the wire between the first and second buildings must also carry the current required in the third building. Therefore, the wire between buildings one and two must have an area

equal to the combined areas that have just been figured, namely 16,500 and 11,000 circular mils, or 27,500 circular mils, No. 6 wire.

Consider next, the nearest building. Load ten amperes, distance 100 feet.

$$\text{Then } \frac{10 \times 100 \times 22}{2} = 11{,}000 \text{ circular mils.}$$

This would represent the size of wire necessary to carry ten amperes to the building 100 feet away from the plant, but the wire between the plant and building one must also carry the current required in buildings two and three. Therefore, the wire between the plant and building must have an area equal to the combined areas, or 38,500 circular mils, corresponding to No. 4 wire.

In case current would never be used in all buildings at once, smaller wires could be used. For example, if current is to be used in one and two at the same time, but not in three, the wire between the plant and building one could be No. 6 instead of No. 4, because the required area would be 22,000 circular mils.

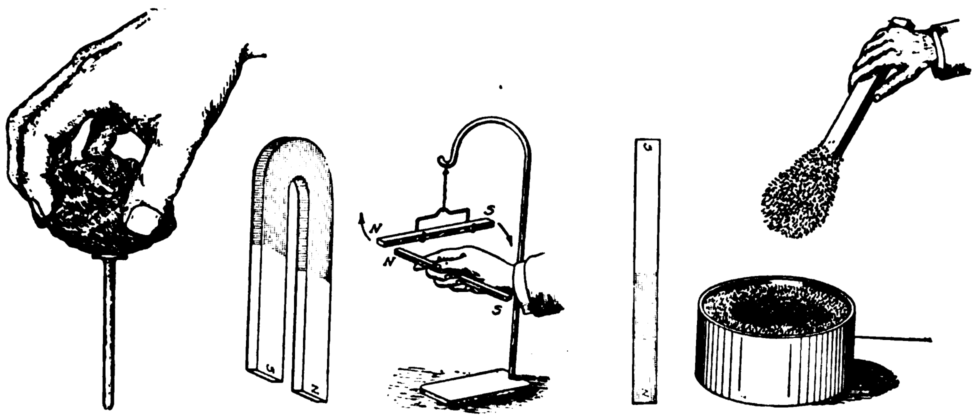
If current is to be used in only one building at a time, No. 8 wire could be used over the entire distance, because the greatest area required for any one load is 16,500 circular mils.

When estimating wire sizes, remember that the plant owner will use more current in his outbuildings later on than he does at the start. There is always likelihood of this, so the wires should be made sufficiently large to take care of any possible future demand for additional current.

# Electricity and Magnetism

IT has been known for many centuries that some specimens of the ore known as magnetite have the property of attracting small bits of iron and steel. Pieces of ore which exhibit this attractive property for iron or steel are known as natural magnets.

It was also known to the ancients that artificial magnets could be made by stroking pieces of steel with natural magnets, but it was not until the twelfth century that the discovery was made that a suspended magnet would assume a north-and-south position. Because of this property, natural magnets came to be known as lodestones (leading stones); and magnets, either artificial or natural, began to be used for determining directions.




**Left to right—Natural magnet; horseshoe and bar magnets; illustrating magnetic attraction and repulsion; polarity of magnet.**

Artificial magnets are now made by passing an electric current through a coil as described later. The forms shown are a bar magnet and a horseshoe magnet.

### Laws of Magnetic Attraction and Repulsion

If two N poles are brought near each other, each is found to repel the other. The S poles likewise are found to act in the same way. But the N pole of one magnet is found to be attracted by the S pole of the other, summarized in the law: Magnet poles of like kind repel each other, while poles of unlike kind attract.

This force of attraction or repulsion between poles is found, like gravitation, to vary inversely as the square of the distance between the poles; that is, separating two poles to twice their original distance reduces the force acting between them to one-fourth its original value, and separating them three times their original distance reduces the force to one-ninth its original value, etc. This explains why the armature of a motor or generator must run as close to the pole pieces as is mechanically practicable.

Iron and steel are the only common substances which exhibit magnetic properties to any marked degree.

### Poles of a Magnet

If a magnet is dipped into iron filings, the filings are observed to cling in tufts near the ends, but scarcely at all near the middle. These places near the ends of the magnet, in which its strength seems to be concentrated, are called the poles of the magnet. The end of a freely suspended magnet which points to the north is termed the north-seeking, or north pole, and it is

commonly designated by the letter N. The other end is called the south-seeking, or south pole, and is designated by the letter S. The direction in which the compass needle points is called the *magnetic meridian.*

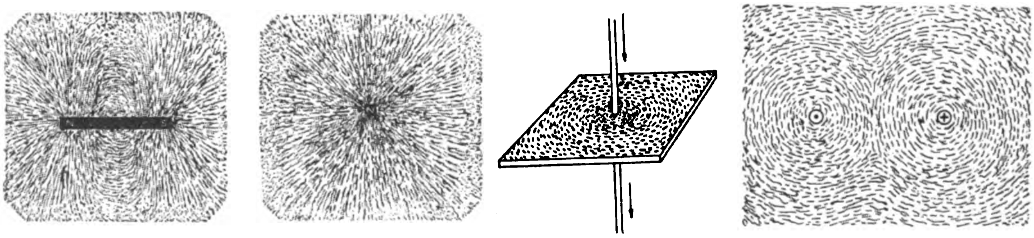
### Principle of the Electromagnet

The identity of magnetism with electricity is readily established by some very simple experiments. By taking a bar of iron and winding some insulated wire around it in the form of a coil and then connecting the terminals of this coil with a battery or other source of current, the bar becomes magnetic. One end of it is the positive, plus, or north pole of the magnet, and the other the negative, minus, or south pole. Break the connections or otherwise "open the circuit" and the magnetism instantly disappears. Reverse the connections to the battery by attaching the wire previously at the positive pole to the negative, and vice versa, complete the circuit again, and the bar is once more magnetic, but now the pole that was previously north or positive is south. The bar is once more a magnet, but its polarity has been reversed by reversing the direction of flow of the magnetizing current. This is what takes place in an electric motor every time a commutator bar passes under the brushes, so that the armature is alternately pulled and pushed around by the rapid changes in the magnetism. The bar of iron with a coil of wire wound around it is known as an electromagnet because it becomes magnetic only when a current is passing through the coil. If a rod of hard steel is substituted for the bar of soft iron and the current passed through it, the bar will be found to be strongly magnetic after the current has been shut off. That is, the bar of steel has, through the action of the current, become a permanent magnet.

To determine the polarity of a magnet it is only necessary to hold a small pocket compass near it; let the compass needle come to rest normally and then bring the compass near to one end of the magnet. If the needle continues to point in the same direction and gives evidences of being strongly attracted to the magnet, the end to which it is being held is the south pole. Bring the compass near to the other end of the magnet, and the needle will turn away sharply, showing that like poles repel each other.

### Magnetic Field

If a bar magnet is placed on a sheet of glass and a handful of fine iron filings thrown around it, they will automatically assume the position shown by the illustration. As originally dropped on the glass some of the filings may not be within reach of the influence of the magnet, but if the glass be gently tapped and tilted slightly, first one way and then another, they will arrange themselves in the symmetrical pattern shown. This gives a graphic illustration of the field of influence of the magnet, usually termed the magnetic field. This field is most powerful at the poles, as will be noted by the attraction of the filings at the N and S points, representing the north and south poles of the magnet. At intermediate points along the length of the magnet the filings will be seen to have placed themselves as if to indicate a circular



**Illustrating the magnetic field. Left to right, of a bar magnet; around one pole; around one wire of a circuit; both sides of a circuit, commonly termed "magnetic lines of force."**

movement of the lines of force. This is the magnetic circuit and these concentric circles represent the magnetic flux, or flow. If the magnet is then removed from the glass and the north pole extension of it placed centrally under the glass, a striking illustration is given of the magnetic field around the pole. A bar magnet has been shown here for purposes of simplicity, but a common horseshoe magnet such as can be had for a few cents will serve equally well for the experiments.

By carrying the experiments a little further, the identity of magnetism and electricity is strikingly shown. Take a piece of cardboard or heavy paper, punch a hole through its center and pass through this hole a wire connected to two or three dry cells. Scatter on the paper the filings used in the previous experiments, then complete the circuit by touching the end of the wire to the other terminal of the battery. The filings will immediately arrange themselves as shown, illustrating the magnetic field which is always present around any current-carrying conductor.

### Lines of Magnetic Force

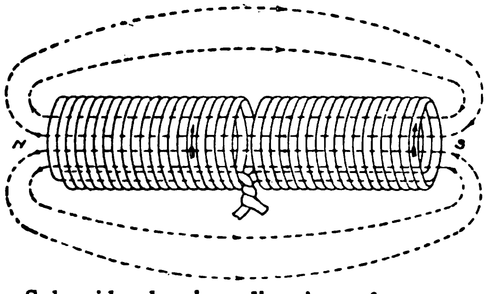
Punch another hole through the cardboard and rearrange the circuit of the dry cells so that the wire passes from the positive battery terminal up through one hole of the cardboard and down through the other hole to the zinc or negative. Scatter the filings as before and touch the loose end of the wire to the negative terminal. The arrangement of the filings will then be that shown, the positive field being at the left and the negative at the right. The fact that the magnetic fields overlap in the curious alignment indicated is simply due to the proximity of the conductors carrying the current.

Another simple method of demonstrating the identity of electricity and magnetism is to place an ordinary pocket compass near a wire carrying a current. If this is a direct current and the needle of the compass whirls around when its north pole is presented to the wire, it is evidence that the current in the wire is positive, since like poles repel. Present the other end of the needle and it will remain stationary even though the compass be shaken, since unlike poles attract. This experiment is accordingly a simple polarity test as well.

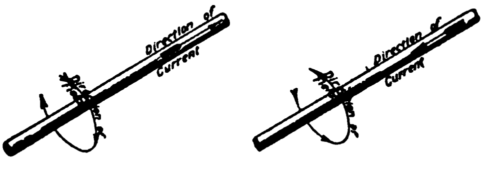
All of the arrangements which the filings assume under the influence of either a magnet or a current, as shown by the various illustrations, indicate that the stresses in the medium surrounding a magnet or current-carrying conductor follow certain definite lines, the lines showing the direction of stress at any point. These are termed lines of force.

### Solenoids

It has been determined that the direction of the current and that of the resulting magnetic force are related to one another as the rotation and travel of an ordinary or right-hand, screw thread. Consequently, if the conductor be looped instead of straight, the lines of magnetic force will surround it as shown. The field of such a loop, if outlined with the aid of filings or explored with a compass needle, will be seen to retain the general character of the field surrounding a straight conductor, so that all the lines will leave




Solenoid, showing direction of current flow and polarity.




Illustrating direction of magnetic field about a conductor, with relation to direction of current flow.

by one face and return by the other, the entire number passing through the loop. Hence one face of the loop will be equivalent to the north pole of a magnet and the other face to the south pole. In fact, the loop will act exactly as if it were a thin disk magnetized perpendicularly to the plane. By winding a number of these loops to make a hollow coil, there is formed a solenoid. Exploring its field shows that the lines of force pass directly through the center or opening of the hollow coil, leaving by one end and returning by the opposite end, as indicated.

If such a solenoid is held vertically and a bar of soft iron placed so that it extends for an inch or so into the lower end of the solenoid, a current passed through the latter will cause the iron to be violently drawn up into the coil and held there. This is the principle upon which the electric governor and some types of circuit breakers are based. As long as the current flows, this rod is strongly magnetic and has all the properties already described. But the moment the current is shut off, the magnetism practically disappears and the rod immediately drops out of the coil by its own weight. Reversing the direction of the current reverses the polarity of the solenoid but makes the effect the same; increasing or decreasing the amount of current sent through it increases or decreases correspondingly the strength of its magnetic field. The principle of the solenoid is used in automatic starting systems to operate electromagnetic switches.

### Effect of Iron Core on Strength of Solenoid

The magnetic flux or flow of lines of force through a solenoid is much greater when an iron core is present than when the coil is empty or a core of wood is inserted. The magnetism flows through the iron as a current would. Soft iron is said to have a high magnetic permeability. The magnetic permeability of air (or a vacuum) is taken as unity and other substances rated accordingly: for very soft iron it may be as high as 2,500, while for substances such as silk, cotton, wood, glass, brass, copper, and lead, it is unity, the same as for air. Such metals are said to be non-magnetic. All insulators are likewise non-magnetic.

### Induction Principles of Generators and Motors

When a current suddenly flows in a wire placed close to another wire, a delicate measuring instrument such as a galvanometer will indicate a momentary current in the second wire. When the current in the first wire ceases, that in the second will likewise cease immediately. This phenomenon is known as induction, and a current is said to have been induced in the second wire.

Winding the first wire in the form of a coil and bringing this coil close to the second wire, will give the induced current considerably greater strength. The induced effect is still further increased in three other ways: first, by inserting an iron core in the coil; second, by winding the second wire in the form of a coil; and, third, by bringing these coils as close together as possible by winding one directly over the other.

### Transformer Principle

The arrangement just discussed is termed an induction coil or transformer (step-up) and is universally employed in connection with ignition systems. The character of the induced current depends upon the relation that the first coil, termed the primary, bears to the second coil, known as the secondary. In the usual ignition coil the primary consists of a few turns of comparatively heavy wire, and a current of about 2 amperes (4 to 5 on starting) is sent through it at a low voltage. The secondary coil consists of a great number of turns of exceedingly fine wire, and the current induced in this is proportional to the relative number of turns between the two and

the value of the current in the primary. The secondary current is accordingly of extremely high potential but of only nominal current value.

### Self-Induction

It has already been pointed out that electricity may be put under pressure or potential, and that the greater this pressure, the greater the amount of work a certain amperage of current will perform, thus affording a direct analogy with steam, water, or air under pressure. An electric current also possesses other characteristics corresponding to mechanical equivalents. Chief among these is inertia and it is the latter that is responsible for what is known as self-induction.

When a current is passed through a coil of wire, a strong magnetic field is set up in the coil owing to the concentration of a great many turns of wire in a small compass. By inserting a core of soft iron wires into this coil, the magnetic field is greatly strengthened, since the permeability of the iron affords a path of slight resistance for the magnetic circuit. There is, of course, a magnetic field surrounding every conductor in a circuit when the current is passing, but the iron core of the solenoid converts a certain part of this current into magnetism. An appreciable time is necessary after the circuit is closed for such a coil "to build up." This "building up" consists of saturating the core with magnetism. Motor and generator armatures and fields are all wound on iron or soft steel cores.

When the circuit is suddenly opened, the current that has been stored in this core in the form of magnetism is as quickly retransformed and its value is impressed upon the circuit, causing a flash at the break. The flash is also aggravated by a certain amount of inertia which the current possesses. We may illustrate this by a stream of water flowing in a pipe. If the water is suddenly shut off by the closing of a valve, it tends to keep on flowing and momentarily causes a great increase in the pressure against the face of the valve, resulting in the familiar "water hammer." The same thing happens when a circuit is suddenly broken, and the higher the potential the more marked this effect will be. The current tends to keep on flowing, and the extra potential which this self-induction gives it will cause it to arc, or bridge, the gap at the break, unless a condenser is provided to take care of this. Every circuit possesses self-induction, but it is only marked in circuits having considerable inductance, that is, in coils, and especially those with iron cores, such as induction coils, circuit breakers, etc.

### Capacity of Condensers

Every conductor of electricity has capacity to hold a charge just as a vessel holds water. But the capacity of a conductor is dependent upon its surface area rather than its cross-section, or cubic volume, and is also influenced by surrounding conditions. Where it is desired to accumulate a considerable charge, as for an ignition spark, a special form of capacity is utilized. This is known as a condenser (a detailed description of which is given later in connection with ignition coils). The ability of a condenser to absorb the rise in potential that occurs through self-induction whenever a circuit containing inductance is opened is also utilized to prevent sparking at contact points. Comparatively small condensers are necessary for this purpose, and they are shunted around the contact points, that is, connected in parallel with the latter. When the circuit is opened the excess energy of the circuit passes into the condenser instead of forming a hot spark at the contacts. The occurrence of any undue amount of sparking at contacts should accordingly be made the subject of an investigation of the condenser connections, or of the condenser itself.

### Comparison of Generator Current to Water Flow

The comparison of air in a room has been made to illustrate the presence of electricity and its characteristics, since it may be made to partake

of all the latter by being put under pressure, allowed to escape through various sized outlets, and made to perform work of differing nature by being utilized at varying pressures and volumes, exactly as electricity is. Where an electric current is produced by a generator, however, the older simile of water flowing under pressure due to the impulse of a pump may serve to make it much clearer. This comparison of a water pump and its piping with an electric generator and its circuits is known as an hydraulic analogue, and, it may be added, there is scarcely any characteristic or function of the electrical current that cannot be similarly compared.

Take, for example, a waterworks system of the type in which a large pump at the power house draws water from artesian wells or a reservoir and forces it into a closed system of piping. Located on this piping system are all the house outlets, street hydrants, and the like. The speed of the pump is regulated so as to keep a certain amount of pressure on the water in the pipes, based upon the average demand at different periods of the day. The pressure is reduced at night and is increased at any time, day or night, in case of fire.

### Pressure and Voltage

This constant pressure in pounds per square inch that the pumps maintain on the supply of water in the entire piping system is the exact counterpart of the voltage, or electromotive force, produced by a dynamo, or generator, when running. Just as the pressure exerted on the water by the pumps depends upon the speed of the latter, so the voltage produced by the dynamo is proportional to its speed. In the case of the pump, the pressure depends upon the number of times that the pistons of the pump reciprocate; in the dynamo, upon the number of times that the coils, or windings, of the armature cut the lines of force of the magnetic field in which it revolves. This is explained in detail later in connection with generator principles.

When the pump moves slowly, there is very little pressure produced in the pipes, and this is the case with the dynamo to an even greater extent, since dynamos are usually designed to run at very much higher speeds, and consequently their voltage, or pressure, drops off very sharply at low speeds. At low speeds they do not generate sufficient voltage to overcome that of the battery.

### Fall in Pressure

When either a pump or a dynamo is running at a constant speed, the pressure, or voltage, produced at the machine is practically constant. But in the case of the water system, the pressure is not the same at the outlet of a branch line a mile away from the power house as it is at the delivery end of the pump, nor is the voltage on a branch circuit at a great distance from the dynamo the same as it is at the terminals of the latter, consequently, the fall in pressure in the water piping is the exact counterpart of the drop in voltage on the electric circuit due to the resistance of the wires. In the case of the water supply, the friction encountered by the water in passing through the pipes is analogous to the resistance which the electric current must overcome, except that bends in a wire do not impose any greater resistance to the current than the same length of wire when straight, whereas, bends in piping greatly add to the friction with a correspondingly greater drop in pressure.

### Friction and Resistance

There is, in consequence, almost an exact parallel between the mechanical friction of water passing through a pipe and that of the electric current passing through a wire. Friction in water piping is inversely proportional to the size of the pipe, and is directly proportional to the length of the pipe in exactly the same way that a wire opposes more resistance to the electric current the smaller the wire is, and the amount of resistance also increases with

the length of the wire itself. In both cases, the product of this friction, or resistance, is heat; and it results in a drop in pressure, whether mechanical or electrical.

### Current and Volume

So far the comparison has been limited entirely to the pressure exerted by the pump on the supply line as compared with the voltage of the generator imposed on the circuit. In a similar way the flow of water from the pipe line may be compared with that of the current in an electrical circuit. Assume, for example, that, in the case of the water-supply system, the pumps generate a pressure of 100 pounds to the square inch. Eliminating from consideration any drop in pressure between the pump and outlet as only tending to confuse the comparison, suppose a half-inch faucet to be opened at a distant part of the system. Then there will flow from the pipe an amount of water proportioned to the size of the outlet times the pressure, or head, back of it. Let us assume that this will be one cubic foot per minute, or, roughly, eight gallons.

In the same way, assume that the generator imposes a pressure of 100 volts on the line and, for purposes of comparison, there is no drop between the generator and the end of the line. So long as there is no outlet open there is pressure on the water in the supply system, but no flow. This is likewise the case with the electric circuit. The voltage is present as long as the armature of the dynamo is revolving, but there is no flow of current in the circuit. A small fan motor, corresponding to the half-inch faucet, is switched on at a distant part of the circuit. There is then a flow of current of, say, one ampere. In this case, the hydraulic analogue reflects exactly the action of the current as compared with the water supply in a pipe. If, instead of opening a small house faucet, we open the valve of a branch main a foot in diameter, there is a correspondingly greater volume of water flowing, but the pressure remains the same. On the other hand, if, instead of a small fan motor, a one-horsepower motor is switched into the circuit, the outflow of current will be equivalent to one horsepower, though the voltage of the circuit will remain the same. (There is, of course, always a voltage drop with every piece of apparatus that the current passes through before completing the circuit by returning to the generator, just as there is a drop in water pressure for every additional length of pipe or open outlet in the system; but, to keep the comparison clear and simple, this is not taken into consideration here.) Thus, in one case, we have one cubic foot of water per minute flowing under a head, or pressure, of 100 pounds per square inch; in the other, a current of one ampere at a voltage of 100; also the fact that the volume of either water or electricity that will flow depends upon the resistance of the outlet. The fan motor is wound to a high resistance, and, consequently, only one ampere of current is required to operate it at its maximum speed. In the same way, the ½-inch outlet will permit only one cubic foot of water to escape per minute. Increasing the size of the outlet in either case increases the flow correspondingly. The simile holds good with the water system up to the point where the outlet becomes too large to permit the pumps to maintain the pressure; but, in the case of the electric generator, the resistance cannot be decreased to zero, since this would result in a short-circuit permitting the entire current output of the dynamo to flow. Unless the dynamo were protected by circuit breakers and fuses, the functions of both of which are explained later, the windings of the machine would be burned out.

### Power Comparison

To go back to the simile between water and current flow, it will be noted that in one case there is a flow of one cubic foot per minute at 100 pounds to the square inch, and, in the other, a flow of one ampere of current

at 100 volts. This flow of water represents power just as the flow of electric current does, and it may be utilized in a similar manner. The product of the volume times the pressure would give foot-pounds in the case of the water and watts in the case of the electrical energy; in other words, one ampere times 100 volts, or 100 watts—almost one-seventh of a horsepower.

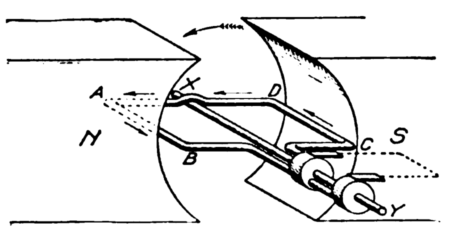
### Circuits

The simile of the water-supply system does not correspond exactly to any type of electric circuit, in that the water does not return to the pump in any case, as the current always must to the generator, to complete the circuit. But it does afford a comparison of the characteristics of both series and multiple circuits, showing to what an extent the illustration of electrical principles may be carried by means of a simple mechanical analogue. For instance, the opening of one outlet after another in a water system reduces the pressure in the entire system, just as the insertion of one piece of apparatus after another in a series electric circuit causes a corresponding drop in voltage for each addition, except, of course, that in case of the series electric circuit it must always be complete, regardless of whether one or a dozen different pieces of apparatus be included in it. In other words, the current must pass through each one of them in turn to complete the circuit. On the other hand, the water system has some of the characteristics of a multiple, or parallel, electric circuit, in that the opening of one outlet does not prevent the use of others, whereas in the series circuit, the breakdown of one piece of apparatus, such as a motor or a lamp, puts all the others out of action by opening the circuit.

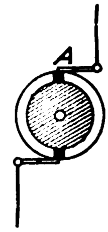
The comparison may be carried still further to illustrate other attributes of the electric circuit. For example, if there be a bad break in one of the large mains of the water system, no water will reach smaller outlets beyond the break in the main, the entire volume flowing out of this opening. This corresponds very closely to a ground or short-circuit on an electric circuit. If one of the wires, instead of carrying the current to the motors or lamps, permits its supply to return to the generator, or battery, by a shorter path, due to faulty insulation or a broken wire touching the ground, no useful work will be performed by the current. It will escape and be wasted just as the water is, with this important difference, however, that in the case of the water pumps, the break in the main will be evidenced only by a marked decrease in the pressure, and the pumps will run to no purpose, whereas the electric generator (with the exception of the shunt type) will still continue to generate its full voltage, and, unless the grounded circuit caused by the break has sufficient resistance, the circuit breaker, or fuses, must operate to protect it.

### Principle of Electric Generator

Whenever lines of magnetic flux are cut by a conductor, for example, a wire passing through them, an e.m.f. (electromotive force) is produced in the conductor, and the strength of this e.m.f. is entirely dependent upon the speed at which the conductor passes through the magnetic field. If, at the time that this is done, the ends of the wire are brought together to form



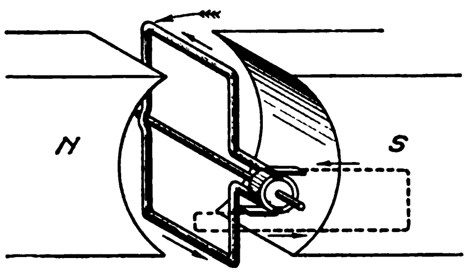

Elementary form of generator which produces an alternating e.m.f.



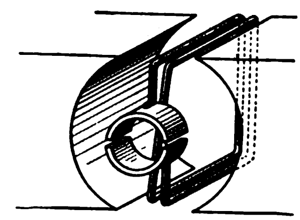

Simplest form of commutator, insulation between the two segments below A.

a circuit, a current will be induced in the conductor. The simplest form of generator would consist of a single loop of wire ABCD arranged to rotate in a magnetic field, as shown. Having its plane parallel to the direction of the magnetic flux, the loop, if it be rotated to the left as shown, will have an e.m.f. induced in it that will tend to cause a current to flow in the direction shown by the arrows.

The value of this e.m.f. depends upon the speed, and as the loop approaches the 90-degree or vertical position, the e.m.f. decreases because the rate of cutting is diminishing, until when the loop is vertical both the cutting




**Elementary generator with commutator instead of collector brushes as in the preceding illustration.**

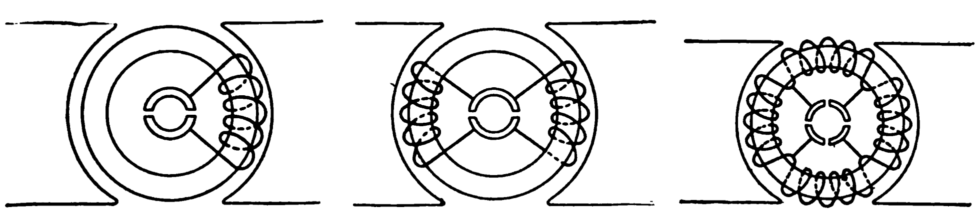


**Elementary generator with two-coil armature and commutator will produce a pulsating D.C.**

of the magnetic flux and the generated e.m.f. are at zero. If the rotation is continued, the rate again gradually increases, until at 180 degrees it is once more a maximum. The cutting, however, in the two quadrants following the 90-degree position has been in the opposite direction to that occurring in the first quadrant, so that the direction of the e.m.f. generated is reversed. Such an e.m.f. is termed alternating because of its reversal from positive to negative values, first in one direction and then in the other, through the circuit. It cannot be utilized for charging a storage battery, and hence it is not employed in connection with farm light and power plants. To convert an alternating current into a direct or continuous current, a commutator must be added.

### Commutators

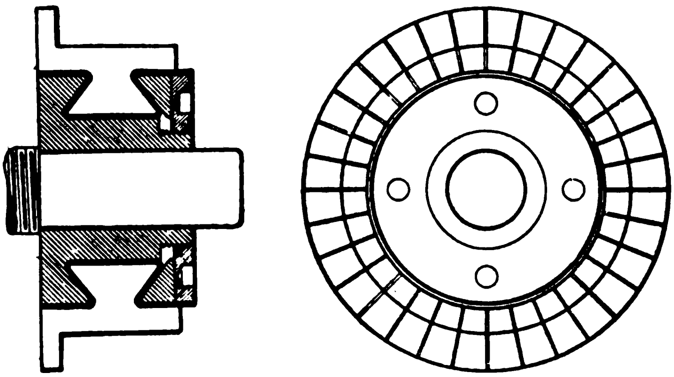
The next cut illustrates a commutator in its simplest form. It may be imagined as consisting of a small brass tube which has been sawed in two longitudinally, the halves being mounted on a wooden rod. The wood and



**Iron core ring armature with one, two and four coils and a commutator.**

the two cuts in the tube insulate the halves from each other. Each one of these halves is connected to one terminal of the loop, as shown in the illustration. Against this commutator two brushes bear at opposite points and lead the current due to the generated e.m.f. to the external circuit. If these brushes are so set that each half of the split tube moves out of contact with one brush and into contact with another at the instant when the loop is passing through the positions where the rate of cutting is minimum (as indicated in the enlarged end view of the commutator shown at A), a unidirectional current will be produced, but it will be of a pulsating character.

This would also be the case, if instead of the single loop, a coil wound on on iron ring be substituted, the only effect of this being to increase the e.m.f. by increasing the number of times the electrical circuit cuts the magnetic flux. Assume that two coils are connected to the commutator bars, instead of the single loop. This arrangement making a simple form of armature. The two coils are in parallel and while the voltage generated by revolving this winding with two coils is no greater than with one coil, the current-carrying capacity of the winding is doubled. The current generated by this form of armature would still have the disavantage, however, of being pulsating. As in the case of the automobile motor, the number of cylinders must be increased to make the power output a continuous unbroken line, so armature coils and their corresponding commutator brushes must be added that one set may come into action before the other "goes dead." By placing an extra pair of coils on the armature, at right angles to the first, as in the four coil armature, one set will be in the position of maximum activity when the other is at the point of least action. While this



**Sectional and end views of commutator construction, the segments usually being molded directly into the insulation.**

armature would produce a continuous current, it would not be steady, having four pulsations per revolution, and it is consequently necessary to increase the number of coils and commutator segments still further to generate a steady, continuous current. This is what is done in practice.

A commutator consists of a number of copper bars or segments, equal to the number of sections in the armature. These bars are separated by sheets of insulating material, usually mica, and are firmly held together by a clamping device consisting of a metal sleeve with a head having its inner side undercut at an angle, a washer similar in shape to the head of the sleeve, and a nut that screws over the end of the sleeve, as shown in the left-hand or sectional view. The sleeve is surrounded by a bushing of insulating material, and washers of the same material are placed between the assembly of commutator bars and the two clamping heads. Each bar is then completely insulated from every other bar and from the clamping sleeve. Commutators are also made by pressing the entire assembly of copper segments together, or molding them, in insulating material, which thus forms the hub or mounting of the commutator as well as the insulating material between the segments. After assembling, the commutator is turned down in a lathe to a true-running cylinder and then sand-papered on its outer cylindrical surface to present a smooth bearing surface for the brushes. At the inner end of the commutator which is closest to the armature windings, the commutator bars are provided with lugs as shown in the sectional view; these lugs are slotted and the armature leads are soldered to them.

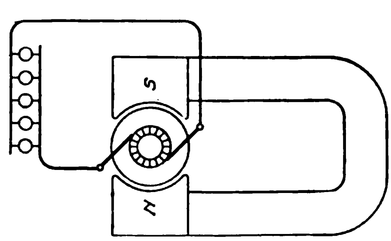
From the dealer's point of view, the commutator is the most important

part of the generator or the motor, since it is one of the first with whose shortcomings he makes acquaintance. The commutator and the brushes are the only parts that are subject to wear. If the time devoted to servicing plants were divided according to the units demanding attention, the battery would naturally come first, brushes and commutators next, regulating instruments, then switches, connections, and wiring, about in the order named. After all of these come, of course, burnt-out armatures or other internal derangements which necessitate returning the units to the manufacturer; but troubles of this nature are quite rare. While this list gives the order of precedence, it has no bearing on the relative importance of the troubles; with respect to the total time taken by each, the battery is responsible for not far from 90 per cent., the commutator for about 5 per cent., all other causes comprising the remaining 5 per cent.

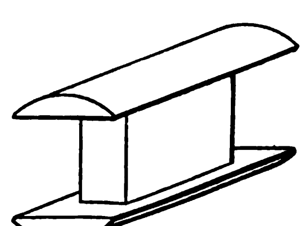
## Armature Windings

In the simple illustration given to show the method of generating e.m.f. in the armature and leading the current to the external circuit, what is known as the ring type of winding is shown. This is inefficient because half the length of the conductor—the portion inside the ring—does not cut any lines of force and hence does not aid in generating the current. A slotted type of armature core is generally employed for small generators and motors and the wire is either wound directly in the slots, or is "form wound," that is, the wire is placed on a wooden form shaped to correspond to the position the coil will taken when in place on the armature. After winding the necessary length of conductor on this foundation, the wire is taped together, and varnished or impregnated with an insulating compound, and baked.

Owing to its high magnetic permeability, iron is universally employed for the core of the armature, since the function of the core is to carry the magnetic flux across from pole to pole of the field magnets, as well as to form a foundation for the coils. However, when a mass of iron is rotated in the field of a magnet what are known as "eddy currents" are set up in the metal itself, and these prevent the inner parts of the mass from becoming magnetized as rapidly as the outer and also cause the interior to retain its magnetism longer. As the efficiency of the generator depends upon the rapidity with which the sections of the armature become magnetized and demagnetized as they revolve, the lag due to these eddy currents is a detriment. To reduce this effect to the minimum, the armature cores are always laminated, that is, built up of thin disks of very soft iron or mild steel, these disks having the necessary slots punched in them to accommodate the winding when assembled on the shaft. The disks are insulated from one another either by varnishing them or by inserting paper disks between them. They are assembled on the shaft and are put together under considerable pressure, various means being employed to hold them in place. These disks are so thin that hundreds of them are required to make an armature core only a few inches long, and when pressed together in place they are to all intents and purposes a solid mass.



**Early type of magneto D. C. generator, showing use of "permanent field."**



**Armature Core of "H" or shuttle form used in ignition magnetos.**

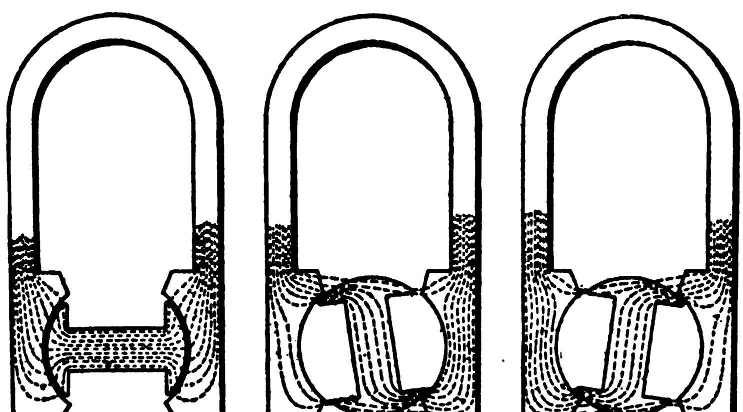
Armature winding, however, is something that is entirely beyond the province of the dealer.. It is a job for the expert in that particular line, and on the rare occasions when an armature does go wrong, it should always be returned to the manufacturer.

### Field Magnets

In the foregoing explanation of the generation of an e.m.f. by a conductor when rotated in a magnetic field and the leading out of the current through a commutator, the presence of the field has been assumed and nothing has been said regarding the method of providing it. The term field is applied interchangeably to the magnetic flux between the pole faces of the field magnets and to the magnets themselves, but it is more generally understood to refer to the latter directly and to the former by inference. There are various methods of maintaining the flux, usually described as "field magnet excitation," but only one of them is applicable to the electric generators employed on farm light and power plants, namely, self-excitation, described later.

### Permanent Field Used in Magneto

The simplest of these, and the first to be designed, employed permanent magnets, from which such a generator takes its name, magneto. The cut is a diagrammatic representation of an early form of the magneto-generator. Since magnetism cannot be maintained permanently at the high flux-density or strength which can be produced by an exciting coil fed by a current, this method is only employed in very small generators, as its bulk for large powers would be excessive. Its great advantage is its simplicity and constancy. The magneto-generator shown, however, is designed to produce a



A B C

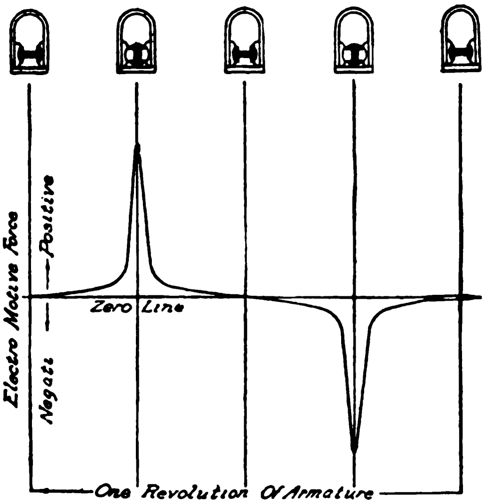
**Illustrating magnetic flux, or flow, through the shuttle armature of a magneto in different positions.**

continuous current, and is not the type in general use on the automobile or farm light and power plants for ignition.

The type installed is made with a two-pole armature as shown. This figure illustrates the core known as a "shuttle" type because the wire is wound around the center of the core in much the same manner as thread is put on a shuttle. These cores are laminated as already described, in all well-built magnetos. The space on the core is filled with a single coil of comparatively coarse wire on low tension magnetos, which generate a low voltage current that is subsequently stepped up through an outside transformer. In the high-tension type of magneto, there is a second winding of fine wire on the core so that the magneto generates a current and steps it up without the aid of any outside devices. In either case, one end of the winding is "grounded

on the core," that is, connected to it electrically, so that the core and other metal parts of the machine form one side of the circuit, while the other end is connected to a stud against which a spring-controlled carbon brush bears, to collect the current.

The operation of the magneto as designed for ignition purposes is radically different from any other form of generator. If unrestricted, the armature of the magneto will always assume the position shown at A, in the illustration showing magnetic flux, and considerable effort will be required to turn it from this position as the magnetic flux through the armature is then a maximum. When the armature is rotated a little over 90 degrees from this horizontal position so that the armature poles leave the field poles, as at B in the same figure, the flux decreases, and when in a vertical position no lines




**Illustrating the rise and fall of A. C. current in a magneto armature during one complete cycle.**

of force pass through it. At this point, the direction of the magnetic flux through the armature core reverses. Having a two-pole armature, the magneto produces an alternating current of one complete cycle per revolution, as shown by the curve, which illustrates the electromotive force generated at the different positions in the rotation of the armature. With the armature in the horizontal position there is a dead point, the e.m.f. curve only starting as the pole pieces of the armature begin to cut the edges of the field magnet poles. It then rises very sharply to a peak, and as sharply drops away to zero again, thus completing one alternation, which is then repeated in the opposite direction. As the present discussion comprises only an introduction to elementary principles and theories, further details of construction and operation of the magneto are given later in the section on "Ignition."

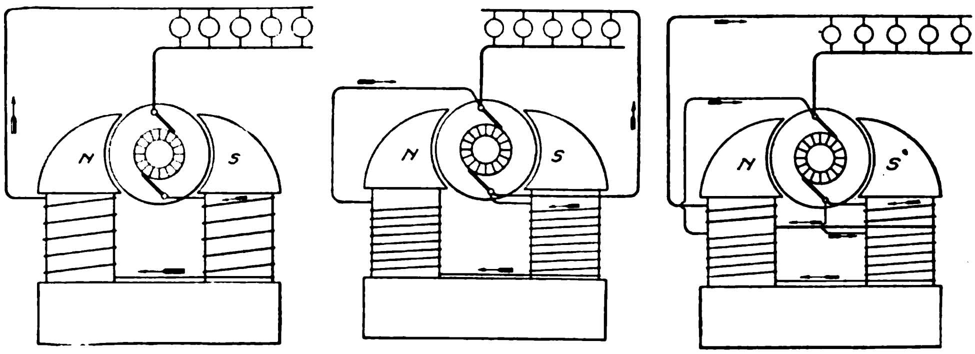
### Self-Excited Fields

In a machine of the magneto type, the only method of varying the current output is to vary the speed of the armature, and it is therefore not well adapted to the majority of uses for which a generator is employed. Consequently, other methods of exciting the fields have been developed, which may be roughly divided into two classes: first, those separately excited, in which current from an independent source is supplied to the field windings. This is restricted to large alternating-current generators and need not be considered here. Second, self-excited fields, which are characteristic of all continuous current generators. In this method all or a part of the current in-

duced in the armature windings is passed through the field coils, the amount depending on the type of generator.

### Series Generator

Where the entire current output is utilized for this purpose, the dynamo is of the series type, and a reference to the section on "Circuits," in connection with the illustration, will make this plain. There is but a single circuit on such a dynamo and while it has the advantage of simplicity, it does




**Left to right. Circuits of series, shunt and compound wound generators. The obsolete bipolar type of generator is shown to simplify the illustrations.**

not generate a current until a fairly high speed is reached, or unless the resistance in the external circuit is below a certain limit. It is also likely to have its polarity reversed so that it is not fitted for charging storage batteries.

### Shunt-Wound Generator

By winding the generator with two circuits instead of one and giving that of the fields a relatively high resistance as compared with the outside circuit on which the generator is to work, a machine that is self-regulating within certain limits is produced. As shown by the cut the main circuit of the generator is that through the armature with which the field winding is in shunt. The current accordingly divides inversely as the resistance and only a small part of it flows through the field coils, while the main output of the generator flows through the external circuit to light the lamps, to charge a battery, or the like, the resistance of this external circuit being much less than that of the fields. But in this type, as well as in the simple series form, the e.m.f. generated varies more or less with the load, and as the latter is constantly changing, it is necessary to provide some means of varying the e.m.f. generated to suit the load, in other words, to make the generator self-regulating. Of the several available methods of doing this, the only one applicable to the small direct-current generators used in automobile lighting and starting systems, is that of varying the magnetic flux through the armature.

### Compound-Wound Generator

There are also several methods of effecting this variation of the magnetic flux, but the most advantageous and consequently the most generally used, is to vary the amount of current in the energizing coils on the field magnets. By adding to the shunt winding a few turns of heavy wire in series with the armature so that the current passes through them, the magnetic flux may be made to increase with the load as it is directly affected by the current demanded by the latter. This combination of the shunt and series is termed a compound winding, and the usual method of effecting it is shown in the

next illustration. Such a machine is called a compound generator, and is the type almost universally used for lighting and for charging storage batteries. Where there is a great range of speed variation, as in a windmill driven generator, this compound wiring is sometimes reversed so as to act against the shunt instead of with it, in order to prevent an excessive amount of flux and a current that would be dangerous to the windings themselves due to a very high speed. The compound winding then opposes the shunt-winding and is termed a bucking-coil or winding.

For greater simplicity, all of the illustrations shown in connection with the explanation of the various types of generators are of the old bipolar type in a form long since obsolete. The field frame, as it is designated may, however, take a number of different forms depending entirely upon the designer's conception of what best meets the requirements of ample power in the minimum of space and with the minimum weight. Typical field frames in general use on generators and motors are circular in form, and in addition to providing a magnetic circuit the field frame also serves to enclose the windings. These are known as "ironclad" types from the fact that all parts are thoroughly enclosed and protected.

## Brushes

Brushes serve to conduct the current generated by the armature to the outer circuit and to the field coils in order that the excitation of the latter may correspond with the demand upon the generator. The brushes originally employed were strips of copper which bore on the commutator; as generators increased in size these brushes were built up of thin laminations of copper. Plain copper brushes in any form, however, cause an excessive amount of sparking which is ruinous to the smooth surface and true running of a commutator. Built-up copper gauze brushes were then adopted, and they were fitted to bear against the commutator. Though an improvement, these did not meet all the requirements and were in turn superseded by carbon brushes, which are now practically universal. The carbon brushes usually bear directly against the face of the commutator, either through a blunt, squared end, or one that is slightly beveled. The brush holders are generally bronze castings attached directly to the field-frame extensions; in them are placed small helical springs under compression, which serve to press the brush against the commutator. Ordinarily, the brushes are composed of a uniformly smooth and homogeneous compound of carbon that soon acquires a glazed surface at its bearing end and wears indefinitely without requiring any attention, but at times a gritty brush will be found. Such a brush scratches the commutator surface, wears unevenly, and is generally a source of trouble.

Badly worn commutators frequently result from the use of improper brushes, or too heavy a spring pressure—also from too light a spring pressure. The manufacturer has found out by experiment and study just what character of brush is best adapted to his particular generator or starting motor and also the exact amount of spring pressure that is necessary to insure the best results. Consequently, much trouble will be avoided if brushes are replaced only with those supplied by the manufacturer of that particular machine, in connection with the brush springs that were designed for it. There are electrical as well as mechanical reasons for this, since both the resistance and current-carrying capacity of carbon brushes vary. This has been taken into consideration by the manufacturer who has provided a brush especially adapted to his machine.

# Principles of Electric Motor Operation

A MACHINE that is designed to convert mechanical into electrical energy or the reverse, is known as a dynamo-electric machine. When its armature is rotated by an external source of power, such as a gasoline engine, water wheel or windmill, it is a generator. By sending a current through it from another generator or a battery it converts electrical into mechanical energy and is a motor. It is evident, then, that a generator and a motor are fundamentally one and the same thing, and that by a reversal of the conditions one unit may be made to serve both purposes. It will naturally depend upon how closely these purposes approach each other so far as their operating conditions are concerned, whether it will be practical to employ the same machine for both. In practice, operating conditions rarely approximate and so except on automobile starting units the same machine is rarely used both as a generator and a motor.

### How Rotation Is Produced

The operation of an electric motor will be clear if the essentials of a dynamo-electric machine and their relations are kept in mind. There is, first, the magnetic field and its poles—two or any multiple thereof; then the armature, which must also have an even number of poles corresponding to the number of segments in the commutator. Each separate coil in the armature winding magnetizes that section of the armature core on which it is wound, when the current passes through it, as its terminals, connected to different segments on the commutator, come under the brushes. In an electric motor having either two or four field poles, and eight, twelve, or sixteen armature poles, it is apparent that every few degrees in the revolution of the armature an oppositely disposed set of its poles is either just approaching or just leaving the magnetic field of two of the field poles. Bearing in mind that like poles repel one another and that unlike poles attract, and that the polarity of both the fields and the armature coils is constantly being alternated by the commutator, we see that each section of the armature is constantly being attracted toward and repelled from the field poles. For example, in a motor assumed to have eight armature coils, as in the present instance, there would be, at a speed of 1,000 R. P. M., 16,000 changes per minute, which makes clear the reason for the very smooth pull or torque that an electric motor exerts.

### Counter E.M.F.

Though being rotated by means of current obtained from an external source of power, it is apparent that the motor armature in revolving its coils in the magnetic field is fulfilling the conditions previously mentioned as necessary for the generation of an e.m.f. The voltage and current thus generated are in an opposite direction to that which is operating the motor. It is accordingly termed a counter e.m.f. as it opposes the operating current. This, together with the fact that the resistance of copper increases with its temperature and that the armature becomes warmer as it runs, explains why the resistance of a motor is so much greater when it is running than when standing idle. The counter e.m.f. approaches in value that of the line e.m.f., or voltage at which current is being supplied to the motor. It can, of course, never quite equal the latter for in that case no current would flow. The two opposing e.m.f.'s would equalize each other; there would be no difference of potential.

### Types of Motors

Being the counterparts of electric generators, electric motors differ in type according to their windings in the same manner as already explained for generators. The plain series-wound motor is nothing more or less than

the simple series-wound generator to which reference has already been made; the shunt and compound motors likewise correspond to the shunt and compound generators. But while the series-wound generator was of extremely limited application and has long since become obsolete, the series-wound motor possesses certain characteristics which make it generally used. It is practically the only type employed for starting service on the automobile, and it is also in almost universal use for railway service. The reasons for this are its very heavy starting torque which increases as the speed of the motor decreases, the quick drop in the current required as the motor attains speed, and its liberal overload capacity. It is essentially a variable speed motor, and, just as the plain series-wound generator delivers a current varying with the speed at which it is driven, so the speed of the motor changes in proportion to the load. These are characteristics which make it valuable for use as a starting motor for the gasoline engine, but render it unavailable for general power purposes. As its speed is inversely proportional to the load, however, it tends to race when the load is light; in other words, it will "run away" if the load is suddenly removed.

Shunt motors and compound-wound motors are the same as their counterparts, the generators of the same types, and are generally used for power in connection with farm light and power plants.

## Dynamotors

As the term suggests, this is a combination of the generator or dynamo and the electric motor, and it is a hybrid for which the automobile starting system has been responsible. It is frequently mistermed a "motor-generator" and while its assumption of the two roles may justify the name, the use of the term is misleading as it becomes confused with the motor-generators employed for converting alternating into direct current. The latter consist of an a-c. motor on one end of a shaft and a d-c. generator on the other end of the same shaft. The two units are distinct except for their connection, whereas a dynamotor is a single unit comprising both generator and motor, and it can perform only one of these functions at one time. The generators used on 110-volt automatic farm light and power plants are dynamotors, one set of windings being energized by the low voltage storage batteries for starting and the other for generating current.

## Batteries

The only other method known for generating a continuous, direct current is by means of chemical reactions in what are known as primary cells. With the exception of the so-called dry cell, a description of these and their workings could be of only historic interest and is accordingly omitted here. As no chemical reaction could take place in perfectly dry substances this part of the name is used simply to distinguish such cells from those using a liquid solution. The dry cell is a zinc-carbon couple, the zinc acting as the container while the carbon is a heavy rod packed in manganese dioxide, together with some moisture-absorbing material. On the contents of the zinc container as thus filled is poured a solution of sal ammoniac and water which forms the active solution of the battery. The cell is sealed at the top to prevent evaporation, since, when the cell does actually become as dry inside as it is outside it is no longer of any use.

The storage battery or accumulator does not generate a current in any sense of the word. By means of a more complicated chemical reaction than that of the primary cell it absorbs a charge of electricity. Upon the completion of the circuit of a storage cell with a suitable load or resistance, such as driving a motor or lighting a lamp, a reversal of this chemical process takes place and the battery redelivers a part of the current which it has previously absorbed. Full details of the characteristics, construction, and working of the storage battery are given in a series of articles under that head.

# Ignition Principles and Systems

A LOW-TENSION ignition system, usually termed "make and break" ignition, uses a low-tension current—i.e., the output of a battery or small generator, employed at the voltage at which it is produced, or, in other words, a primary current. A high-tension uses a high-voltage current produced by passing the output of the battery or other source of supply through a step-up transformer (induction coil). As this is taken from the secondary winding of the coil, it is sometimes referred to as a secondary current. It is the result of induction and is commonly termed a high-tension current owing to its great voltage or potential. The battery produces current of

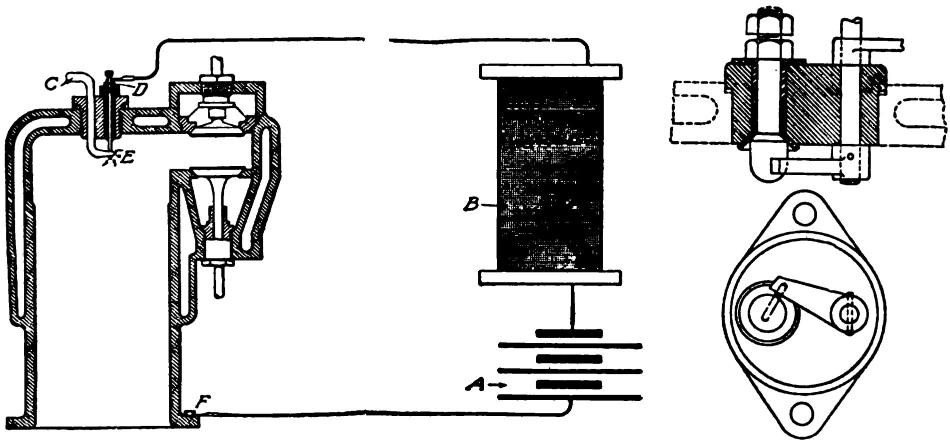



**Diagram of low-tension ignition system, battery spark coil and ignitor. Details of make-and-break ignitor at right.**

high amperage value at 6 to 8 volts, which after being passed through the coil becomes a current of microscopic amperage value at anywhere from 10,000 to 25,000 volts, according to what the designer of the coil thought was sufficient potential to produce a good spark, that is, to enable it to readily jump the gap in the points of the plug. The curve shows the voltage necessary to force a spark across a given distance in air under various pressures.

As the low-tension current will not jump an air gap, a further distinction between the two systems is the employment of totally different types of spark plugs. In the former, a mechanically operated plug, i.e., one that is held closed until the maximum current is passing through it and is then suddenly opened by being mechanically tripped by a cam or rod operated by the engine, is essential. Such a plug produces a spark that is immensely superior in heating value and, consequently, in igniting ability, to the usual thin spark that bridges the gap of a high-tension plug. But this most desirable quality is likewise quickly destructive of the contact points, necessitating frequent readjustment of the mechanically operated plugs. Moreover, the mechanical lag or time element of operation, due to the inertia of the numerous moving parts, renders it difficult to make a low-tension spark plug suitable for a high-speed engine.

### Low-Tension System

The cut shows diagrammatically the essentials of a low-tension system for a single-cylinder motor. A is the battery (magneto, dynamo, or any other suitable source of current), B is a spark coil (a single wound coil that adds to the value of the spark by self-inductance, and not an induction coil). and C, D, and E are the elements of a make-and-break device that is mechanically actuated at regular intervals by the motor itself to produce the

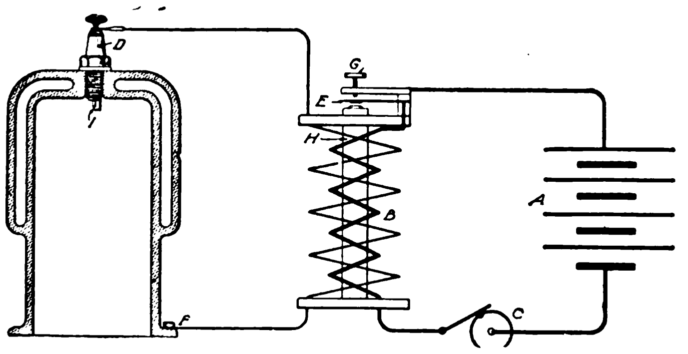
sparks within the cylinder. As shown in the drawing, the circuit is completed by grounding the wires from one side of the battery on the cylinder base, or any other portion of the machine, as at F. In this figure D is a small insulated plug entering the interior of the cylinder, usually through one of the valve caps, while C is a movable arm that makes and breaks contact with B, at the point E, when it is given a slight rocking movement. For the best results this rocking movement must be very sharp and rapid, in the nature of a snap, and it must, of course, be correctly timed to occur in proper relation to the movement when the spark is required.

The chief advantage of low-tension ignition is its immunity from troubles by short-circuiting by leakage of the current through poor insulation or across moistened terminals. This led to its almost universal employment on motor boats for a number of years, but it has since been generally abandoned even for marine use so that it is now only to be found on stationary engines, the low rotative speeds of which make it practical.

### High-Tension System

High-tension ignition systems are based on the fact that when a sufficiently high potential is impressed upon a current of electricity, it will leap an air gap or other break in the circuit of a width dependent upon the potential or voltage itself. In bridging such a gap, the current becomes visible in the form of an arc, flash, or spark, depending upon its duration and intensity, and it will readily ignite a gasoline or other gaseous fuel mixture.

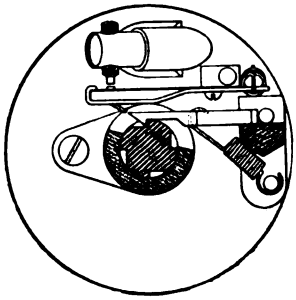
The essentials of a high-tension system are shown diagrammatically in the illustration. A is the source of current, a battery, as indicated by the conventional sign, placed in a primary circuit that also includes the contact maker C, the primary winding of the coil B, and the vibrator G. The contact maker C is positively driven by a connection with some revolving part of the motor, so that it makes contact at the exact time ignition is required in each cylinder.



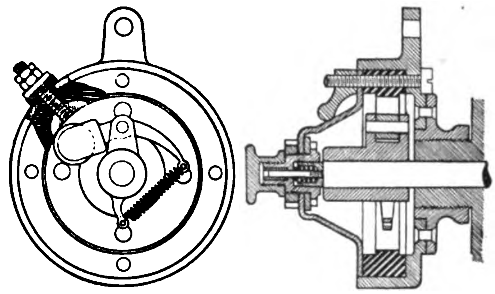

**High tension ignition system, battery A, induction coil B, timer C, spark plug D, vibrator of induction coil G, ground connection F.**

With a system of the type described, when contact is made the first result is attraction of the vibrator blade E by the magnetized core H of the coil. This, by drawing E away from the contact screw G, at once breaks the primary circuit again, and this demagnetizes H, with the result that E again springs into contact with G. The effect of this is to cause a rapid series of current surges through the coil B, as long as the contact maker C maintains the contact.

Each time a surge of primary current passes through a coil, a secondary current of very high voltage is induced in the secondary circuit, which is grounded on the cylinder at F and connected at B with the spark plug. This



**Details of Atwater Kent Interrupter**



**Ordinary wipe contact type of timer, or interrupter**

plug, for high-tension ignition, has an open gap of about 1/32 inch at I, across the resistance of which gap the current will jump, because of its high tension. Ignition is thus effected by a rapid succession of sparks across I.

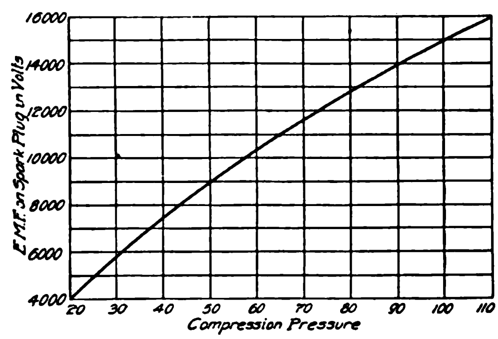
This briefly describes what may be termed the rudiments of a high-tension ignition system and the diagram shows their relation to one another. Of course, this simply has reference to a single-cylinder motor. For each extra cylinder in an ignition system of the type illustrated, there is another contact point on the timer and another coil or a distributor having a secondary contact for each cylinder, so that but one coil is needed for any number of cylinders.

## Ignition Spark Control Devices

It was largely due to the crudity of the timing device that so much difficulty was experienced with early ignition systems. As the term indicates, the timer closed the circuit through the coil at exactly the moment necessary to produce the spark in the cylinder ready to fire. But the long wiping or rolling contact usually employed was so wasteful of current that it quickly exhausted even a small storage battery. A roller contact timer is shown in the illustration. The coil vibrators were another serious source of loss.

The difficulties with roller contact led to the adoption of a totally different principle embodied in the Atwater Kent interrupter. This affords an exceedingly brief contact with an abrupt making and breaking of the circuit. The effect is to produce a strong current surge and a heavy spark, but of the briefest duration. The advantage of the latter is that great current economy is realized.

This has led to the development of other devices along similar lines, and, with the unfailing source of current now provided by the storage battery makes it practical to use battery ignition on farm light and power plants.



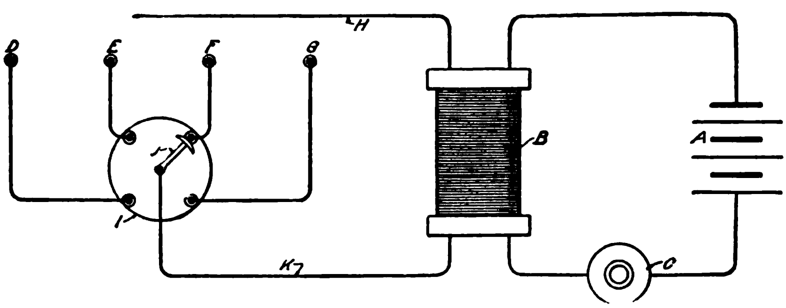

**Voltage necessary for high tension ignition with relation to compression pressure in cylinder.**

## Coils and Vibrators

Mention has already been made of the function of the induction coil in stepping up the voltage in order that it may bridge the gap in the spark plug. A coil is also employed in connection with a low-tension system, but it is simply a single winding on an iron core which intensifies the current by what is known as self-induction. Though it raises the voltage by what may be termed the accumulation and sudden release of electrical energy acting in conjunction with a magnetized core, due to the sudden making and breaking of the circuit, it is not an induction coil as that term is ordinarily employed.

The latter has two distinct windings, one of a few turns of comparatively coarse wire, and the other of many thousand feet of exceedingly fine wire, with high-grade silk insulation. After completing the coil, consisting of two superimposed windings and an iron-wire core passing through their center, it is placed in a box filled with melted paraffine wax which, upon solidifying, greatly enhances the resisting power of the insulation to breakdown, due to the great difference in potential between various parts of the secondary winding To set up an induced current in the secondary winding, the primary circuit must be quickly opened and closed.

The breaking of the primary circuit is accomplished by the use of a vibrator, a typical form of which consists simply of the thin blade of spring steel at E, provided with an armature at the free end to intensify the attraction of the coil H, and adjacent to the adjusting screw at G, by which the




**High-tension ignition system for four-cylinder motor with non-vibrator coil. Battery A; coil B; timer C; distributor I-J; spark plugs D, E, F, G; ground connection H.**

distances between the contact points can be accurately set. (Illustration of diagram of high tension ignition system.) In addition to these elements it is usual to provide a screw adjustment for increasing or reducing the tension of the vibrator blades.

Contacts in the best vibrators are made of platinum-iridium alloys, which are very hard as well as extremely resistant to the very high temperatures of the small arcs that form across the terminals each time the contacts are separated. In cheaper coils, German silver and other metals often are much used for contact points, but they will not work satisfactorily for any length of time.

A vibrator coil is necessary for each cylinder, each coil being energized as the timer passes over the contact corresponding to it, thus putting it in connection with the battery at the moment that particular cylinder is to fire. However, the coil cannot act before its core becomes "saturated," that is, thoroughly magnetized, and it must then pull its armature down against the tension of its spring, so that there is both an electrical and a mechanical lag, or, in other words, an appreciable amount of time elapses between the moment the circuit is closed by the timer and that at which it is again broken by the vibrator to cause the spark in the cylinder. A delicate adjust-

ment is most sensitive and minimizes the lag besides economizing on current, but it is difficult to maintain. A stiff adjustment, on the other hand, will remain operative for a longer time, but its greater inertia makes the motor sluggish in action while the current consumption is increased several times over. Despite the use of platinum contact points, the heat of the spark is such that the latter burn away rapidly, necessitating frequent adjustment. It is difficult to adjust four vibrators so that they will operate uniformly.

### Non-Vibrator Coil

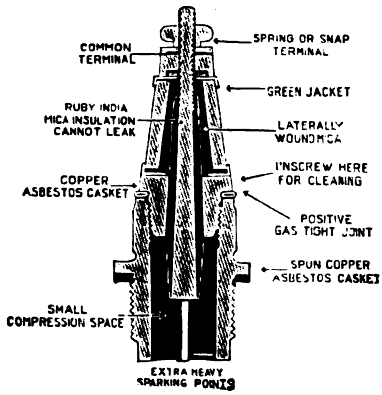
As the term indicates, this is simply an induction coil minus the vibrator. But instead of using four coils, as with the vibrator type, a single coil is employed, and a distributor is inserted in the secondary or high-tension circuit. The essentials of such a system are shown in the diagram, a battery being indicated as the source of current. The timer C is driven by the camshaft of the motor so that the battery circuit is successively closed and opened in the usual firing order of the cylinders, four contacts being made for each two revolutions of a four-cylinder, four-cycle motor. The contact is of sufficient duration to permit the coil to "build up," i.e., to have its soft iron core become thoroughly magnetized, and is then quickly broken. At the instant that the latter occurs, the finger J of the distributor is passing the contact of the cylinder F to be fired. The timer and distributor must accordingly be driven synchronously, so that the contacts in both occur simultaneously. This is accomplished by combining them in a single unit, as in the Atwater Kent "Unisparker," "Connecticut," "Philbrin," and similar systems.

### Distributor

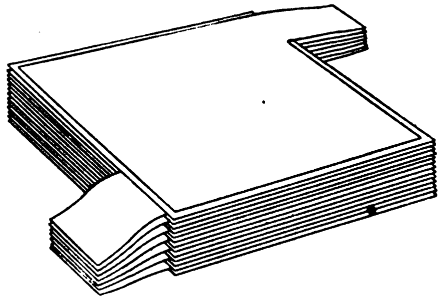
This is simply a modification of the timer, designed to handle the high-tension current, and distribute it to the different plugs. It takes the place of the multi-unit coil in which an independent coil is employed for each cylinder. Owing to the high voltage of the secondary current, actual contact is not necessary in a distributor, a small gap or clearance presenting no obstruction to the passage of the high-tension current, so that wear at this point is avoided. In the earlier types, a brass arm passing close to contact points, or sectors embedded in hard rubber, was usual. Carbon brushes making contact against the disk by means of light springs, were subsequently adopted and are now commonly used. As the carbon is very hard and its contact surface becomes glazed by the friction, the wear is practically negligible. The complete wiring of a distributor system is shown in the preceding diagram. H is the ground or common-return connection of the secondary circuit and K is the connection to the distributor I, from which the high-tension current is distributed by the arm J to the spark plug leads D, E, F and G.

### Condenser

The condenser is an electrical "capacity" which hold an amount of electricity proportioned to the area of its surfaces and to the insulation or dielectric employed. This is utilized to absorb the excess current passing at the moment the primary circuit of the ignition system is opened by a vibrator, bringing about a quick cessation of the current and preventing the burning that would otherwise occur at the contact points. The charge thus absorbed is immediately returned to the circuit in the form of a discharge, when the points come together again and a higher potential value is impressed upon the current. A condenser consists of conducting surfaces placed between insulating surfaces, known as the dielectric. For ignition work, the conducting surfaces are sheets of thin tinfoil between sheets of paraffined paper. The paraffined paper overlaps the tinfoil all around to




**Section of a spark plug (Splitdorf) showing relation of its parts.**

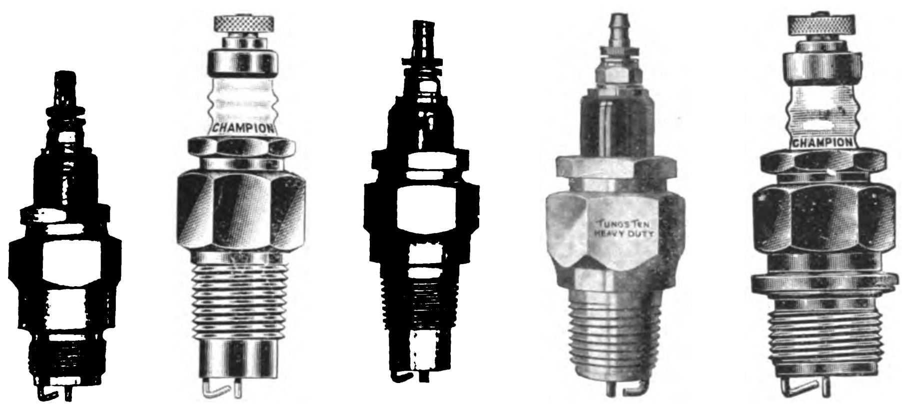


**Sketch of ignition condenser; the tabs are on the tinfoil sheets.**

the extent of an inch or more to prevent a discharge over the edges of the sheets. A condenser practically eliminates sparking at the contact points and is also used with the contact breaker of a magneto.

## Spark Plugs

No small part of the trouble experienced with early ignition systems was due to the defective design of the spark plugs employed. Where an over-rich mixture is delivered by the carburetor, i.e., one containing too much gasoline in proportion to the air, a certain amount of the carbon is unburned and remains in the cylinder in the form of soot. This is greatly increased by an excess of lubricating oil finding its way into the combustion chamber. The heavier carbons of this burn to the same consistency and are also deposited on the piston head, cylinder walls, valves, and other exposed surfaces in the form of a flint-hard coating. The end of the spark plug receives its share and, as the carbon is an excellent conductor, the plug is accordingly




short-circuited, so that the current, instead of jumping the gap between the points, takes a path of lower resistance across the carbon-coated insulating surfaces.

The spark plug is the "business end" of the ignition system and no matter how elaborate or efficient the essentials of the latter may be, its successful operation is governed entirely by that of the plug. As originally designed, the insulating material filled the shell at the sparking end, affording a direct path for the current as soon as this small surface became covered with car-

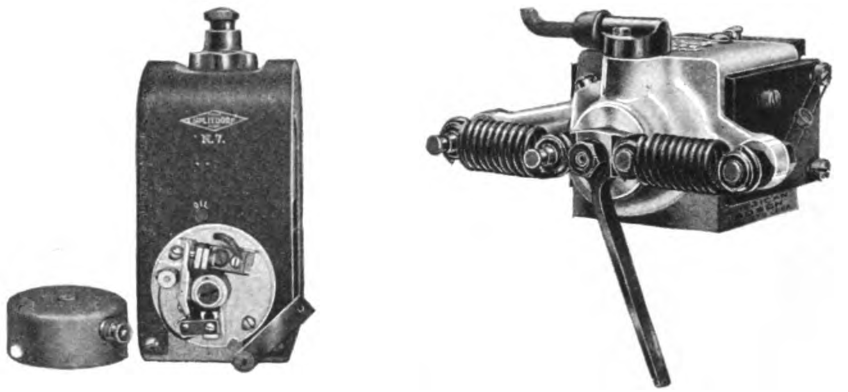
bon. To overcome this, a recess was allowed between the insulation of the central electrode and the outer shell. This simple expedient constitutes a basic patent (Canfield) under which all spark plugs are manufactured. Porcelain, mica, or artificial stone is used as the insulating material, the first-named being most generally employed.

### Ignition Magnetos

The magneto is simply a small dynamo in which the fields consist of permanent magnets, instead of electro-magnets, the cores of which only become magnetic when a current is passed through their windings. Hard steel, when alloyed with tungsten, retains a very substantial percentage of its magnetism, after having been once magnetized. Its retaining power is further increased by placing a "keeper," or armature, across the poles or ends. The advantage of a permanent field for magneto use is that it is at its maximum intensity regardless of how slowly the armature is revolving so that a good spark is produced at very low speeds; while its initial value cannot be exceeded no matter how fast the machine is run, so that the armature winding cannot be burned out. All magnetos generate an alternating current so that when used with a coil there is no necessity of frequently making and breaking the circuit, as is done by the vibrator of a coil handling direct current, the alternate surges of current from zero to maximum of opposite polarity producing the same effect more efficiently.

### Low-Tension Magneto

A low-tension magneto is nothing more or less than the simple instrument which formed part of the thousands of telephones of the hand-ringing type still to be found in rural districts. Built with more powerful magnets and to give a greater current output at a lower voltage, it was employed in connection with low-tension ignition systems. As the mechanically operated make-and-break plugs are timed, the magneto is simply revolved



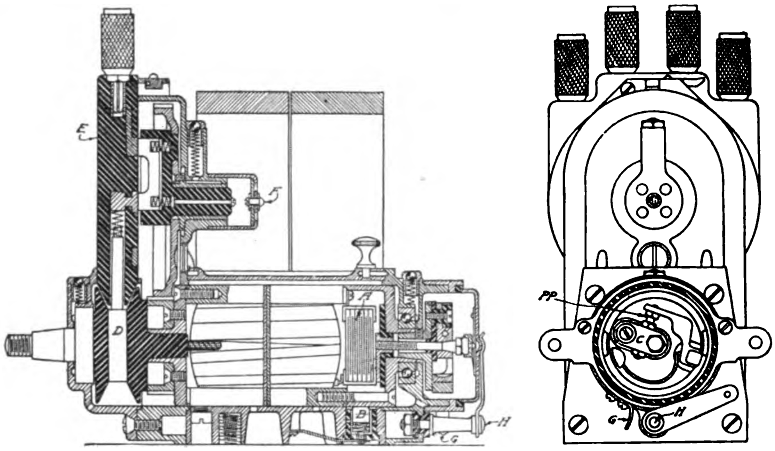
**Types of Low-Tension Magnetos—Splitdorf and Bosch**

continuously without reference to the motor timing, the current being constantly delivered to the circuit through the usual collector ring and brushes. Magnetos of this type are used to a great extent on slow-speed stationary engines.

### High-Tension Magneto

Essentially all magnetos are the same: that is, they have a permanent magnet field and a two-pole armature. In what may be best identified by terming it the true high-tension type, there are two windings on this armature, a primary winding of comparatively coarse wire in which the current is generated, and a secondary winding of fine wire, the same as an in-

duction coil. A magneto of this type is timed with the motor according to the number of cylinders, being driven at crankshaft speed in the case of a four-cylinder motor and at one and a half times crankshaft speed in the case of a six. In addition to the usual current-collecting device, it is equipped with a contact breaker or interrupter, such as that shown. Except at the points in the revolution at which the spark is to occur in the cylinder, the



**Section and End View of High Tension Magneto (Bosch)**

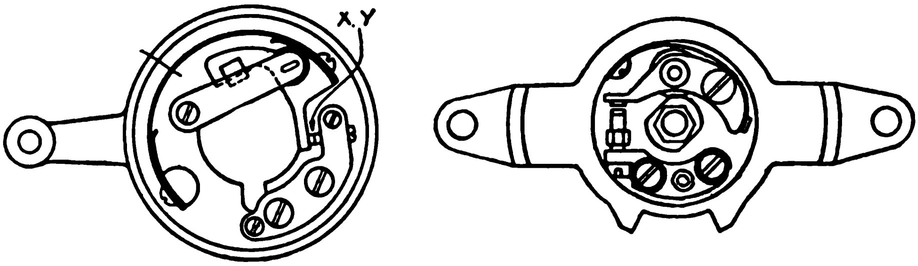
armature circuit is normally short-circuited upon itself. This permits it to "build up," so to speak; that is, as the armature poles come within the most intense part of the field, the current in the armature winding reaches its maximum value and, at this moment, the contact points of the breaker are opened and a strong current is induced in the secondary winding. As the distributor runs synchronously with the contact breaker, the circuit to one of the plugs is closed at the same time the spark occurs at it.

A sectional view of a true high-tension magneto is shown in the next illustration. In this the primary and the secondary windings on the shuttle armature are entirely separate to insure better insulation. These windings are not shown in section in the illustration, the usual insulating tape winding being indicated on the armature. Twice during every revolution of the armature, the primary circuit is opened at the platinum points PP of the circuit breaker, the interruption occurring substantially at the moment when the primary current is at its maximum. From the primary winding, the current is conducted to the stationary member of the contact breaker C through the terminal B. A is the condenser. One terminal of the secondary winding is connected to the end of the primary winding, as in a coil, and the other connects with the high-tension collector ring D, from which it is conducted through a carbon brush to the distributor.

## Spark Timing

Like a steam engine, an internal combustion motor depends for its power output on the mean effective pressure developed in the cylinder, usually referred to as its m.e.p. This effected directly by three factors: first, the initial compression of the charge, that is, the pressure to which the piston compresses the gaseous mixture on its upward or compression stroke just before firing; second, the time at which the charge is ignited; and third, the length of the stroke. It is with the second factor alone that this phase of the ignition problem is concerned. In contrast with the steam engine in which the steam as admitted is at a comparatively low pressure and expands gradually throughout the stroke, the pressure developed in the inter-

nal combustion motor at the moment of ignition is tremendous, but it falls off very rapidly. The impulse given the piston is more in the form of a sharp blow than a steady push, as with steam. The mean effective pressure developed depends very largely upon the pressure reached at the moment of explosion and this in turn depends upon the time ignition occurs with relation to the stroke. To be most efficient it must occur at the point of maximum compression, i.e., when the piston is exactly at the upper dead

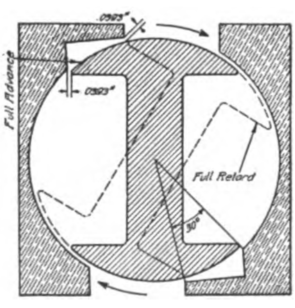



**Types of magneto contact breaker boxes by means of which the timing of the spark is advanced or retarded.**

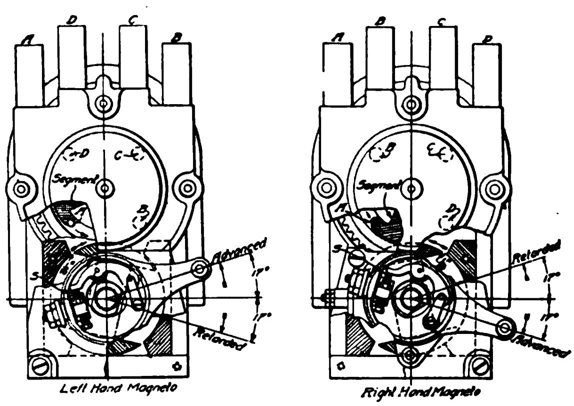
center on the compression stroke. As both a mechanical and an electrical lag, or delay, must be compensated for, the setting which will give maximum efficiency at 500 R. P. M. will be much too slow at 1,500 R. P. M. and the spark would then not take place until after the piston had started down again and the pressure had dropped considerably, causing a great loss in power. On the other hand, an attempt to run the motor slowly with a spark timing that would give the best results at high speed would often result in causing the explosion to take place against the rising piston. This is evidenced by a hammering sound and a great falling off in the power.

## Advance and Retard

Means are accordingly provided in the majority of ignition systems for causing the spark to occur earlier or later in the cylinders. This is termed advancing and retarding the spark. When operated with the spark retarder the combustion is incomplete, the gas continues to burn throughout the stroke, and a greatly increased percentage of its heat has to be absorbed by the water jackets, causing the motor to overheat. On most farm light and power plants this is taken care of automatically.



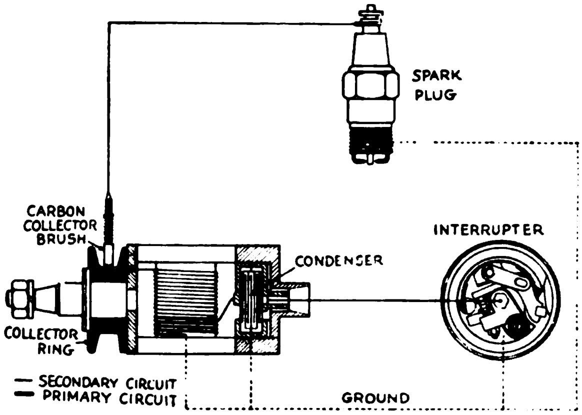

**Extended Pole Pieces of the Simms Magneto, by means of which the spark has the same value at full retard as at advance.**




**Illustrating method of rocking magneto contact breaker box to advance and retard time of spark occurrence (Splitdorf).**

## Magneto Timing

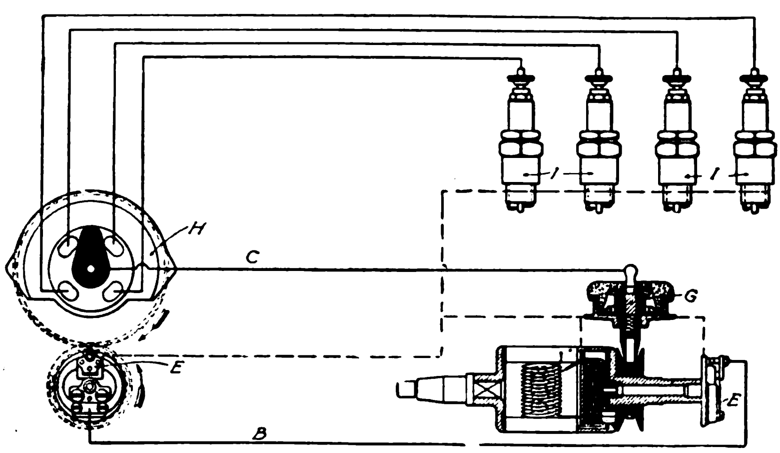
Timing is usually 30 to 40 degrees, which means that the spark occurrence can be advanced or retarded half that distance from a neutral line representing the upper dead center position of the piston. As shown by the illustration, the allowance is 34 degrees in the Splitdorf magneto, "left" and "right" in this connection having reference to the direction in which the magneto armature is driven. The necessity of providing this allowance, however, in-




**Circuit of a high tension magneto ignition system showing but one cylinder (Bosch)**

troduces a complicating factor in magneto design. As already mentioned, most magnetos are fitted with bi-polar armatures, i.e., there are two extensions or pole pieces between which the winding is placed. This will be clear upon reference to the cut showing the armature core of a Simms magneto. The phases are accordingly 180 degrees apart. That is, the current in the armature winding only reaches its maximum value twice per revolution, and as these maxima are really "peaks," there is not much leeway for variation one way or the orther, if the greatest current value is to be utilized.

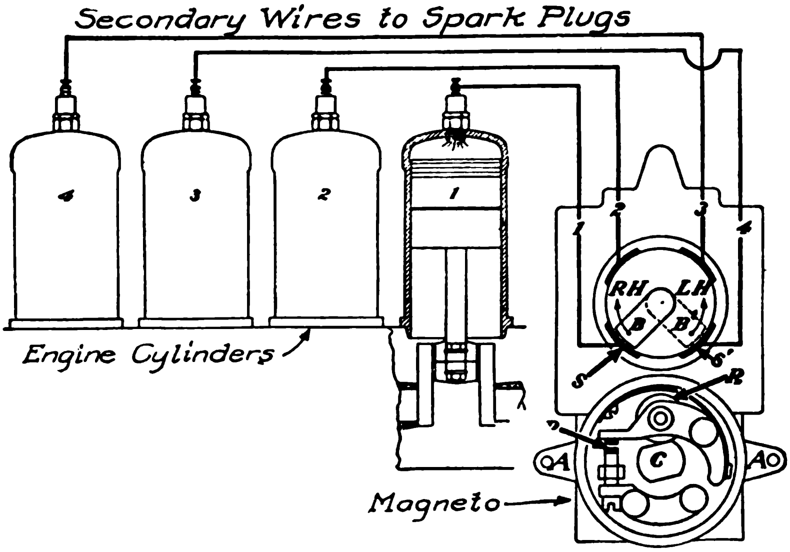
The Eisemann, Herz, Atwater Kent, Connecticut, Westinghouse and other ignition systems may be had with automatic advance operated by a centrifugal governor.



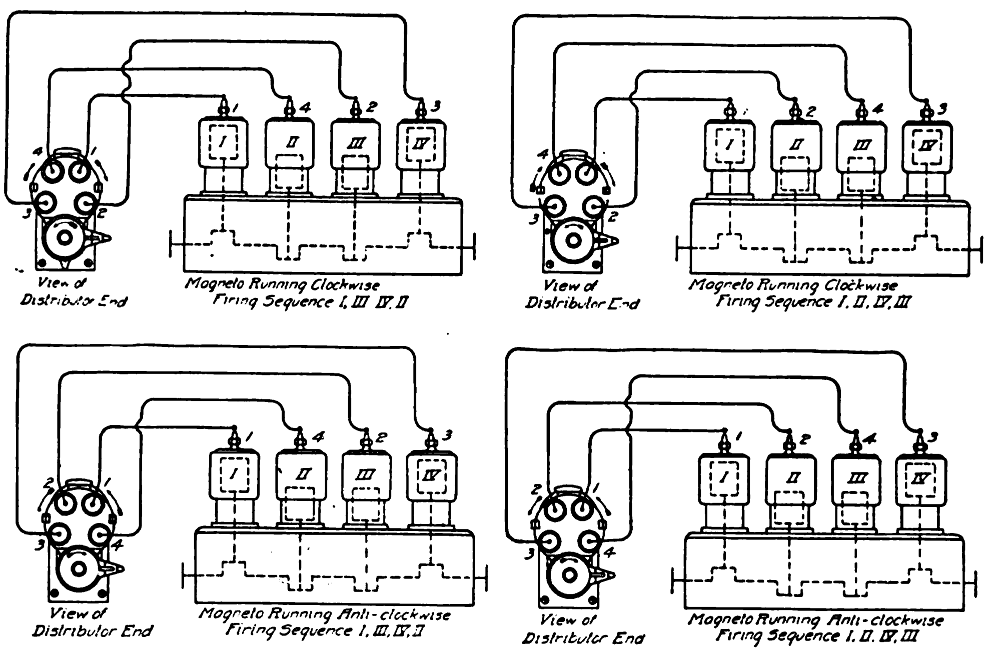

**Circuit of high-tension magneto ignition system for four-cylinder motor. For greater clearness the distributor H is shown separately, with the contact breaker E. G is the safety spark gap (Bosch).**

### Firing Order in Ignition Timing

It is naturally quite as important that the sparks occur in the different cylinders of a multi-cylinder motor in the proper order, as that each individual spark should take place at just the right moment. Regardless of the number of cylinders, the crankshaft throws are always in pairs. Hence, the pistons rise and fall in pairs and the cylinders of these pairs (which have no relation whatever to the method of casting the cylinders themselves) naturally cannot follow one another in firing, the firing order alternating




**Illustrating the firing order of a four-cylinder motor. A, contact breaker box; C, cam; R, roller. RH indicates position of distributor brush on right hand motor; LH on left hand motor. (KW Ignition Co.)**




**Firing Sequence of Four-Cylinder Motors with Right and Left Hand Magnetos.**

from one pair to the other. For example, 1, 3, 4, 2, as in the upper diagram, or 1, 2, 4, 3, as in the diagram next to it, the motors in both these instances running "clockwise," i.e., with the crankshaft turning from left to right. A similar variation is possible with the motor turning "anti-clockwise" or from right to left, as shown in the two lower diagrams, which show firing orders of 1, 3, 4, 2, and 1, 2, 4, 3, the changes being made by shifting the distributor connections to the spark plugs of the various cylinders. In the case of a high-tension battery system using unit coils, the timer connections are varied in the same manner.

### Battery Ignition Systems

Where there is a constant source of current supply available as from the storage battery of a farm lighting plant, a battery system of ignition is often employed. This being a counterpart of the magneto systems already described but taking current from the battery. The Westinghouse, Atwater Kent and Connecticut are examples of this type.

The Westinghouse ignition unit is a combination of all the essentials of magnetic ignition, i.e., the interrupter, distributor, induction coil, and condenser, brought together in a compact unit adapted for mounting directly on the engine. Its components are the counterparts of the same essentials on the magneto, except that the interrupter cam has four lobes, so that no further description is necessary.

The Atwater Kent system is based on a "single spark" interrupter and was the pioneer in making battery ignition successful on the modern automobile before the advent of the perfected lighting generator, the current source usually being a dry-cell battery. It was considered an advantage

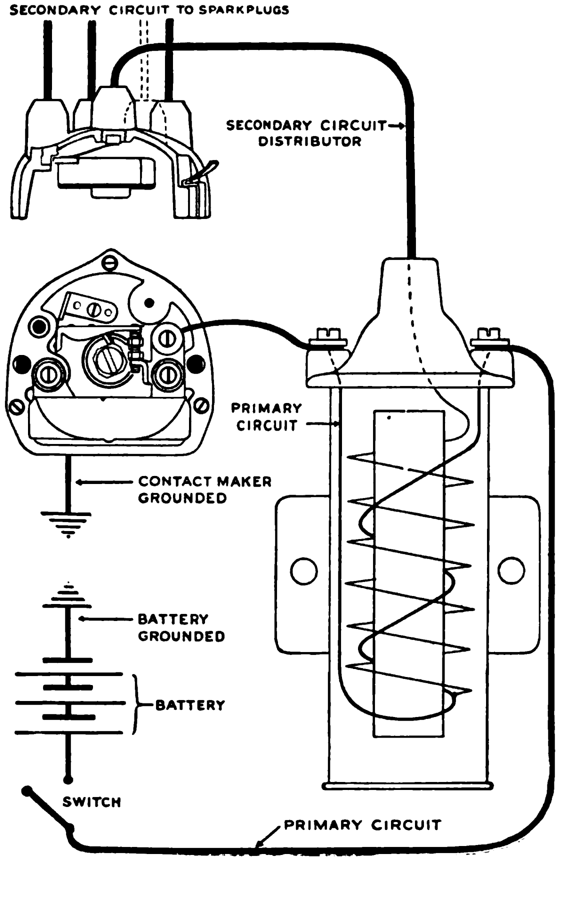



**Diagram of circuit of Atwater Kent Battery Ignition System. The distributor unit, contact breaker, or interrupter, and non-vibrator induction coil are all mounted together in a single self-contained unit.**

in earlier years to produce a series of high-tension sparks in the cylinder on the theory that, if the first failed to explode the charge, it would be fired by the subsequent sparks.

Adjustment of the contact points is made by removing one of the thin washers from under the head of the contact screw, and the gap should be .010 to .012 inch, never exceeding the latter. Where more accurate means of determining this distance are not available, it may be gaged with a piece of manila wrapping paper which should be perfectly smooth. With the aid of a "mike" (micrometer) a sheet of paper of the proper thickness can be selected. The contacts are of tungsten and as the moving parts are all of glass-hard steel, very accurately machined, the wear is negligible so that adjustment is not required oftener than once in a year or so.

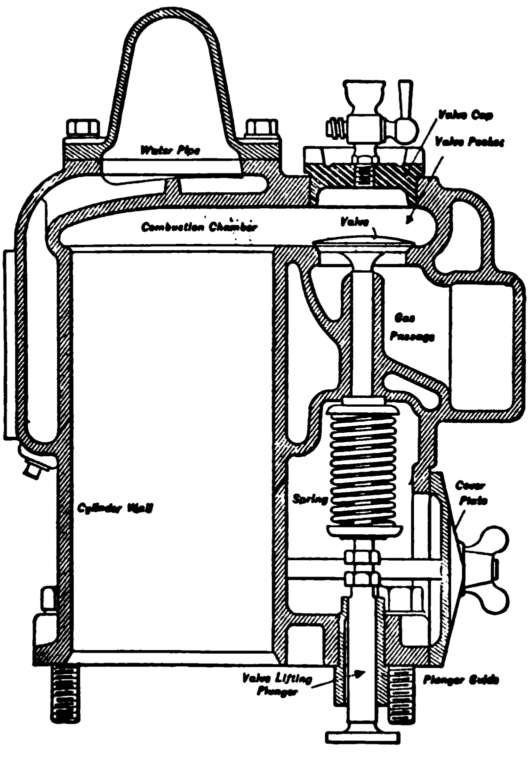
With this interrupter it is impossible to run the battery down by leaving the switch closed inadvertently, as the contacts are never together when the moving parts are idle. The remainder of the system comprises an induction coil (nonvibrator) and a high-tension distributor.

# Principles of Gas Engine Operation

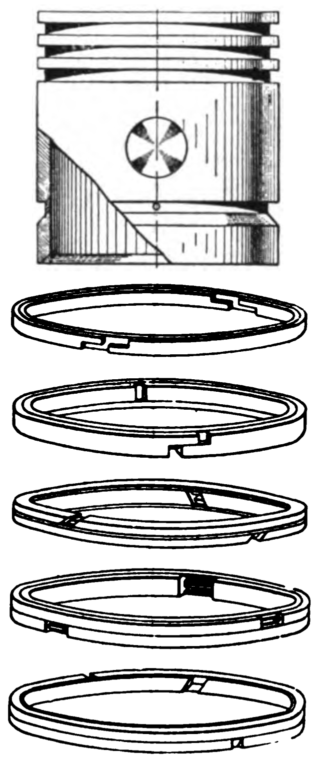
THE engines used in connection with farm light and power plants are often referred to as gasoline engines, kerosene engines, oil engines and gas engines. With minor differences in detail these are all one and the same thing, technically known as an internal combustion engine in that the fuel is actually burned in the cylinder of the engine instead of in a boiler apart from the engine as in the case of a steam engine. Regardless of the nature of the fuel used, all of the various types of internal combustion engines used in connection with farm light and power plants work on the same principle. All hydro-carbons when mixed in certain proportions with oxygen are highly explosive. Crude oil, gasoline, kerosene and natural gas are all hydro-carbons, or a natural combination of hydrogen and carbon in a readily combustible form. When any of the liquids mentioned are converted into a very fine spray or vapor, they combine readily with the necessary proportions of air which supply the oxygen for combustion. An explosion is simply extremely rapid combustion, or burning.

## Essentials of the Engine

In order to utilize the power developed by the extremely high rise of pressure resulting from an explosion, it must take place within a closed chamber. This is the cylinder of the engine and a portion of it in which the explosion takes place is the combustion chamber. The explosive mixture of gas and air is led into the cylinder through the inlet valve; it is fired or ignited by a spark plug, or a make-and-break igniter, and, after the power developed has been used, the burnt gases escape through an exhaust




Details of internal combustion engine cylinder and valve.



Various types of piston rings and piston.

valve. To develop the maximum power from the explosive mixture, it is necessary to compress it.

This is done by the piston which moves in and out of the cylinder. The piston compresses the charge of fuel on its upward or "compression stroke" and it also serves as a means of transforming the power developed by the explosion, first into reciprocating, or back and forth, movement to the connecting rod and then through the crankshaft of the engine, into rotary movement.

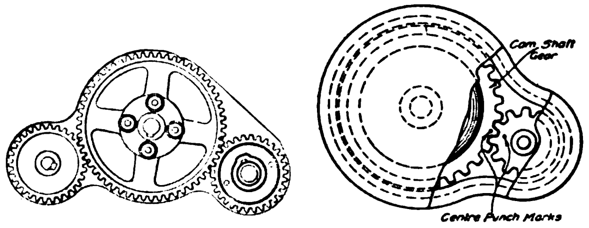
### How Compression Is Maintained

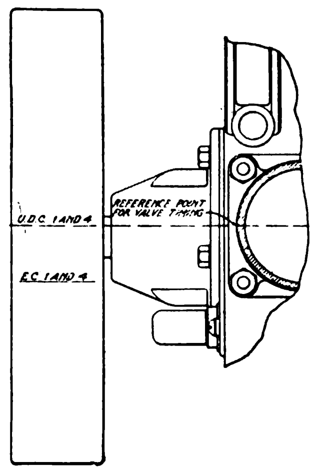
To utilize this compression effectively, the piston must be a gas-tight fit in the cylinder since the pressure at the moment of ignition rises to between three and four hundred pounds and a large part of this would be lost between the piston and the cylinder walls unless special provision were made to prevent it. The accompanying cut which shows a section of a single cylinder, also illustrates the details of a piston and some of the various types of piston rings employed. The piston is made of cast iron and three heavy grooves are turned in it near the head. Into these grooves are sprung the piston rings which are slightly larger in diameter than the piston and have sufficient spring to hold them tightly out against the walls of the cylinder. To prevent the escape of the high pressure gases through the joints in the ring, special forms of joints are provided, a number of them being of patented construction. The large hole about at the center of the piston is for the piston pin, also termed the wrist or gudgeon pin, to which the connecting rod is attached.

The groove shown in the lower part of what is termed the skirt of the piston is an oil groove. This serves to remove the excessive oil thrown up by the splash of the crank, from the walls of the cylinder. Otherwise this excess oil finds its way into the combustion chamber where it is burned, forming a carbon deposit and sooting the spark plugs, besides making the engine smoke badly. This excess oil is scraped off the cylinder walls by the groove shown and the oil itself escapes into the body of the piston through small holes drilled in the bottom of this groove. Sometimes this groove is fitted with a piston ring, termed an oil ring.

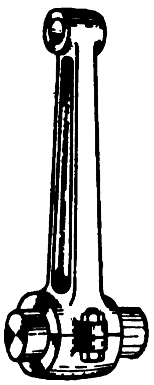
### Timing and Timing Gears

In order that the valves may open and close in the proper order and at the right time, also that the spark may occur in the cylinder at the proper moment, there must be timing gears. These drive the camshaft, with cams to open the valves, also the ignition timer or magneto. In the central figures of the illustration accompanying this section there is shown a typical

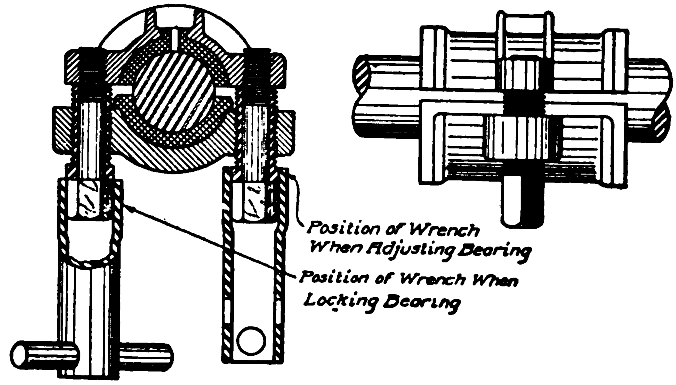



**Two types of timing gear trains and method of checking engine timing by reference marks on flywheel and crankcase.**



Typical gas engine connecting rod. Generally a drop-forging.




One method of taking up wear in a connecting rod bearing. A commoner method is the use of shims between the cap and rod.

timing gear, consisting of the pinion attached to the crankshaft of the engine and a gear of twice the size on the camshaft. This reduces the speed of the camshaft to half that of the crankshaft since each valve only opens every other revolution and the ignition spark only occurs at the same intervals in a four-cycle engine. These gears must naturally mesh in a certain relation in order that the valves and ignition may take place at the proper part of the cycle. In a high speed engine, they are given considerable advance, the valves being opened and closed and the ignition circuits closed a number of degrees in advance of the moment the piston reaches either upper or lower dead center.

This is termed the timing of the engine and in case the gears are not marked to identify this point, whenever it is necessary to take them off the engine, they should be properly marked so that they can be placed back in the same relation without having to check up the timing of the motor. At the right of the same illustration is shown another form of timing gear in which an extra shaft is provided for a magneto and water pump. This is the reason for the extra gear. At the extreme left of this illustration is shown the method of checking the valve-timing of a four-cylinder motor. What is known as the reference point for valve-timing is marked on the crankcase, while similar reference points are marked on the rim of the flywheel. In the illustration the line on the flywheel corresponding to the reference point on the crankcase shows that that is the upper dead center of cylinders 1 and 4.

The line stamped on the flywheel rim just a few degrees before reaching this point reading EC 1 and 4 shows that that is the point at which the exhaust valves of cylinders numbers 1 and 4 close and it also indicates that this is a fairly high speed motor in which the exhaust valves are closed five to eight degrees before the piston reaches the upper dead center. The reference marks for the opening and closing of the inlet valves and the exhaust valves of cylinders 2 and 3 are on a part of the rim of the flywheel not visible in the illustration, but it will be apparent that it is only necessary to turn the flywheel over to bring one of these marks in register while the reference point on the crankcase to be able to check the timing of any of the valves as well as the ignition.

### Purpose of the Flywheel

Since the explosions only take place every other revolution and are in the nature of a sharp blow, rather than steady pressure, there must be some means of smoothing out these blows and keeping the engine running over the idle strokes. This is the flywheel, a heavy wheel in which most of

the weight is concentrated in the rim so that it stores up power. Once revolving at a good speed neither the lack of power for a few revolutions, nor the intermittent impulses of the power strokes tend to alter its speed perceptibly. The remaining member is the crankshaft to which the piston is attached by means of the connecting rod; it also carries the flywheel and the driving pinion of the timing gear which opens and closes the valves through the camshaft and also controls the time at which the spark shall occur in the combustion chamber. The foregoing complete all of the essential members of a gasoline engine of the four cycle type, with the exception of the carburetor or similar device in which the gasoline or other fuel is converted into a spray or vapor and mixed with the right proportion of air.

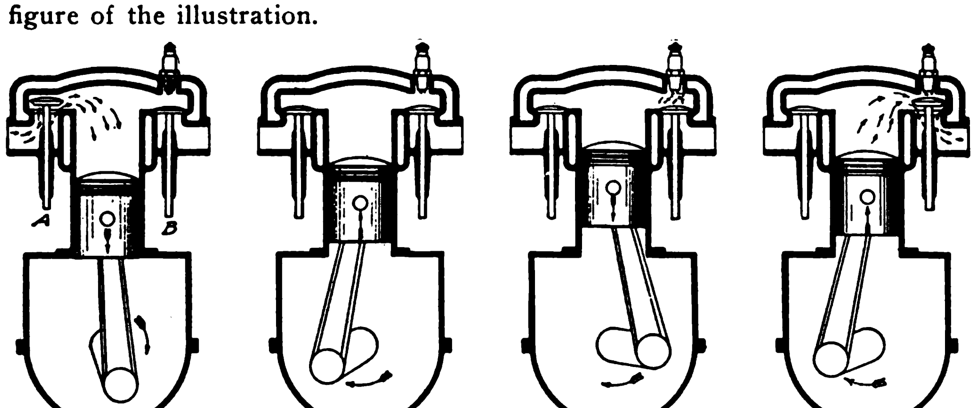
## Cycles of Operation

Reference is made above to a four-cycle engine. This is literally a four-part cycle, a cycle being a series of operations continually repeated in the same order. In the accompanying illustration showing in outline the section of a cylinder, valves, spark plug, piston, connecting rod and crankshaft of a four-cycle engine, the four parts of the cycle are as follows:

The piston is moving downward on what is known as the intake, or suction stroke in the left hand view. As the piston leaves the upper dead center, or slightly before that moment in a high speed engine, the intake valve opens as shown in the left hand figure of the illustration. The piston then draws a mixture of air and gasoline vapor into the cylinder in exactly the same manner as a pump sucks water. That is, by reducing the pressure in the cylinder so that the outside atmospheric pressure forces air through the carburetor or mixing valve and this air picks up and carries with it a certain amount of gasoline spray which has been sucked through the nozzle of the carburetor. When the piston reaches the lower dead center on this stroke the valve closes.

The cylinder is then in the position shown in the second figure from the left in the illustration. Both valves are closed and the piston is rising on what is known as the compression stroke. Just before the piston reaches the upper dead center on this stroke in a high speed engine, the timing gear of the ignition system closes the circuit of the latter so that a spark passes at the gap of the spark plug, the explosion occurs and the piston is then driven downward by the expansion of the burning gases.

This is termed the power stroke and when the piston reaches the lower dead center on the power stroke or just before it, the timing gear brings the exhaust valve cam around and lifts the exhaust valve as shown in the fourth figure of the illustration.




**Illustrating the four essentials of a cycle in the operation of a four-cycle engine. Admission of vaporized fuel; compression of explosive mixture; ignition and expansion; clearing cylinder of burnt gases.**

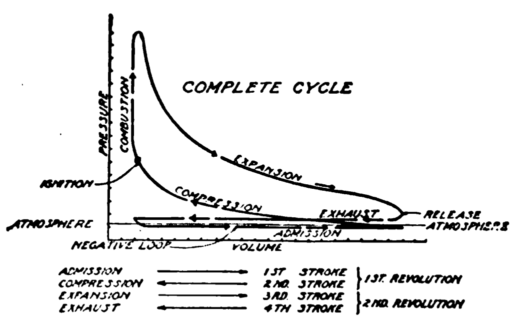
The piston then rises on the exhaust stroke and drives the burned gases from the explosion out through the exhaust valve. Just before the piston reaches upper dead center on this stroke the exhaust valve closes.

### Indicator Cards

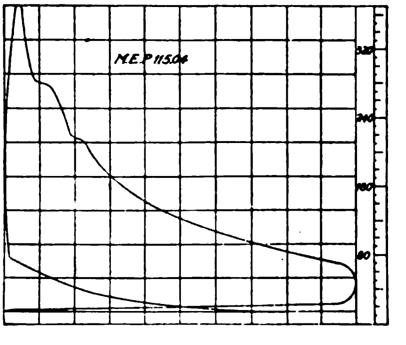
By means of an instrument known as an indicator, what is taking place inside of the engine cylinder is traced on a card and this tracing compared with standard scales so as to figure the actual power being developed by the engine. The indicator cards also show whether the engine is operating properly at every part of the cycle. In the accompanying illustration a conventional indicator card is shown, each part of the cycle being identified. The base line on the card represents atmospheric pressure so that on the first stroke of the cycle, known as the suction stroke, the pressure drops below atmospheric, this part of the card being indicated by the arrow pointing to the right and labeled "admission." At the end of this stroke, the piston starts in the opposite direction and begins to compress the charge as will be noted by the rise in the curve marked "compression."

At this point of maximum compression, the ignition takes place and the charge is fired. This raises the pressure in the cylinder to between three and four hundred pounds per square inch and at the same moment the piston starts downward under the impulse of the expanding gases, the third part of the curve being referred to as the "expansion." Close to the end of this part of the cycle, usually termed "power stroke," the exhaust valve opens and the burned gases escape from the cylinder, the indicator card showing that at the end of the exhaust stroke, there is still remaining in the cylinder a pressure of 15 to 20 pounds.

To the right of this conventional indicator card is shown a card taken from an engine in actual operation, the figures on the scale at the right hand end of the card representing pounds per square inch. By comparing this card with the one at the left, the details of the operation of the engine may be checked. This card by the way shows an engine operating under very favorable conditions. By tracing the compression stroke, it will be noted that what is termed the precompression pressure reached 75 pounds per square inch at the moment of ignition. Upon being fired the burning gas reached a maximum pressure of 370 pounds per square inch and that the expansion curve is good, showing a mean effective pressure of 115.04 pounds per square inch. The actual power delivered by the engine is calculated from this indicator card by computing the total area of the space included within the curve, this being done with the aid of a special instrument termed a planimeter.



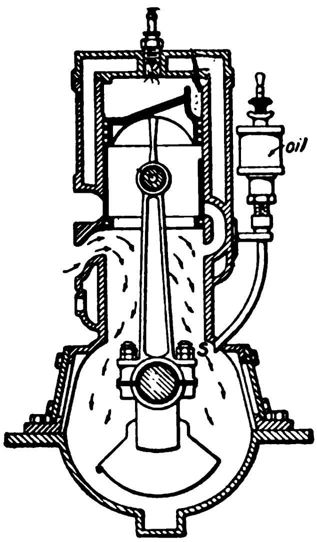

Theoretical indicator card illustrating what goes on inside of cylinder during each part of cycle.



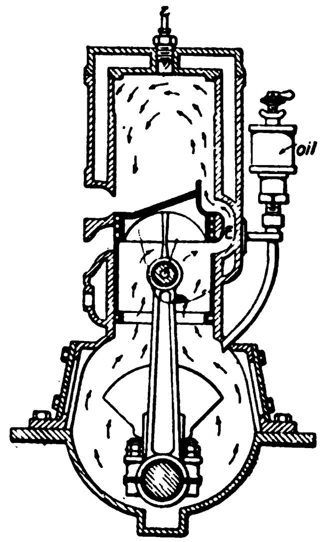

Actual indicator card taken from an engine in operation. Figures at right indicate pressure in lbs. per square inch, maximum pressure 370 lbs., mean effective pressure 115.04 lbs.

## Two-Cycle Engines

As the term indicates, this is an engine which operates on the two-part cycle principle instead of the four. The piston draws in a charge of gas on one part of the stroke and fires it on the next, so that there is an explosion for every revolution of the motor. There are a number of different types




**Illustrating construction and operation of a three-port two-cycle engine. Fuel admitted to crankcase through port on upstroke just before ignition. By-passed from crankcase to combustion chamber at end of exhaust stroke.**




of two-cycle engines, but these differences do not affect the general principle. The accompanying illustration shows what is termed a three-port type of two-cycle motor. In this type, a partial vacuum is created in the crankcase by the upward stroke of the piston and then, as indicated by the arrows on the left hand side of the illustration, the fuel mixture flows into the crankcase. On the downward stroke of the piston this gas in the crankcase is compressed and when the piston comes all the way down on the power stroke, it opens the by-pass, marked E on the right hand illustration and the gas then flows through this by-pass to the combustion chamber. Just at this moment the exhaust port on the left hand side of the cylinder is wide open and one of the drawbacks of the two-cycle type of engine is the fact that some of the fresh gas may escape with the burned gases through the exhaust port. While thousands of two-cycle engines are in use for marine purposes, very few of them are employed in this field for driving generators.

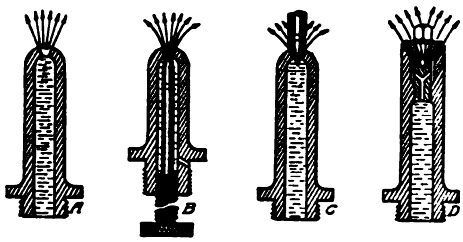
## Fuel System

The method of supplying fuel to the engine and converting it into a spray or vapor for mixture with air differs in various makes of engines. The fuel system consists of a tank to hold the supply, a means of delivering this supply and a carburetor or mixing valve for converting it into vapor. If the tank is placed higher than the carburetor, the fuel is fed by gravity; if at a lower point, it is raised by a small pump or by means of a vacuum tank, both of these devices being operated by the engine itself. A gravity supply or a vacuum tank is usually used in connection with a carburetor, while a pump is employed to supply a mixing valve, in connection with which there may or may not be an overflow to take care of the excess fuel raised by the pump, this depending on the type. The vacuum tank is operated by means of suction from the motor, a small bore copper tube being connected from the carburetor manifold to the vacuum tank. This lowers the pressure in the tank and the atmospheric pressure on the gasoline in the supply tank raises it. A float valve in the vacuum tank periodically opens and closes, keeping

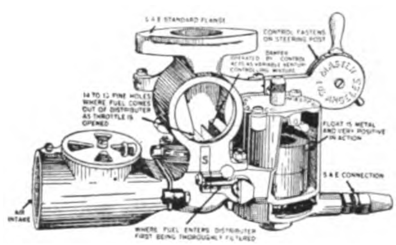
a chamber below it filled with gasoline which is fed by gravity to the carburetor. The working of one of these tanks will be clear from the accompanying illustrations showing a sectional view.

### Carburetors and Mixing Valves

The function of the carburetor is to convert the liquid gasoline into a very fine mist or vapor, and at the same time mix it with the right proportion of air to form an explosive gas. Regardless of the makes or types, all carburetors consist of a float chamber, holding a small supply of liquid gasoline, a nozzle or needle valve, a mixing chamber, a main air valve, a means of admitting additional air in accordance with the speed of the engine and a throttle vave The accompanying sectional views of various types of carburetor clearly show the relative locations of these various essentials. The opening of the spray nozzle, or needle valve, is located a small fraction of an inch above the level of the gasoline supply in the float chamber. The partial vacuum created by the downward stroke of the piston causes atmospheric pressure to force gasoline from the float chamber up through the nozzle and at the same time draws in a supply of air around this nozzle. The




**Types of carbureter spray nozzles, also termed atomizers and needle valves, for converting liquid fuel to spray.**



**Details of a carbureter showing float chamber at right, worm and intake at left and mixing chamber in center.**

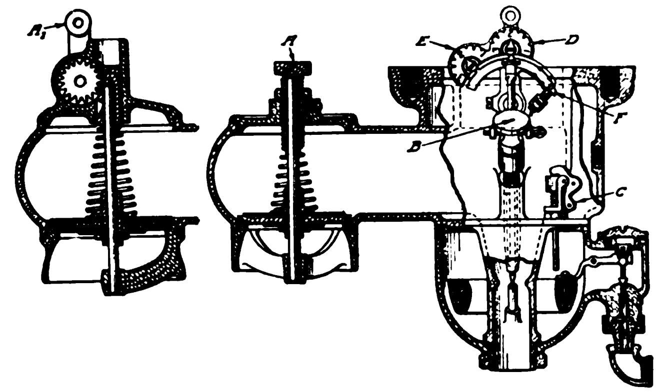
mixing chamber is given a special form, termed a Venturi tube, which causes the incoming air and gasoline to be whirled around violently so that they are thoroughly mixed. The conversion of the liquid gasoline into a vapor is accelerated by water-jacketing the carburetor itself and connecting the air intake of the carburetor with a "stove," or heat collector, on the exhaust manifold, so that part of the waste heat of the engine is utilized to warm the fuel. With kerosene a large amount of heat is necessary.

This serves several purposes. It cuts down the fuel consumption by preventing liquid fuel being drawn into the cylinder and also prevents the dilution of the lubricating oil in the crankcase as some of this liquid fuel is apt to find its way down past the piston.

### Details of the Carburetor

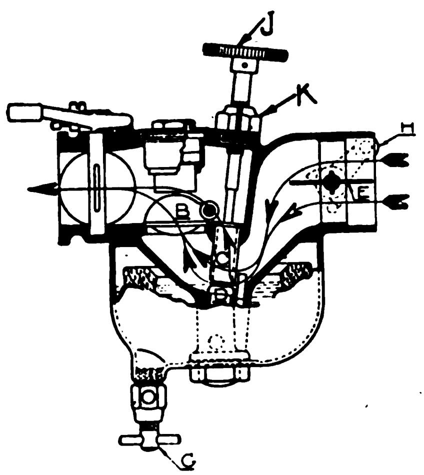
In connection with this section are shown illustrations of two or three standard types of carburetors to illustrate their details. These are not necessarily exactly the same as carburetors now employed on farm light and power plants so far as construction is concerned but their principles of operation are identical. At the left side of the first illustration are shown the four standard types of nozzles or needle valves in general use. The first at the left A, is a fixed bore nozzle, in that no provision for adjustment is made. The second B is termed a needle valve in that the opening of the nozzle is adjustable by turning the needle up or down to close or open the orifice of the nozzle. Both C and D are merely variations of B. In the design of all spray nozzles the object is to draw the fuel through such a fine opening that this will immediately convert it into a very fine mist and the latter

Section of one type of Schebler carbureter referred to in the accompanying text. The main air intake surrounds the needle valve or nozzle.

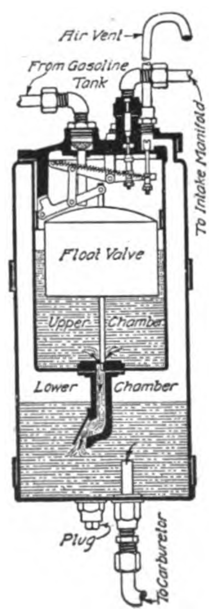



under the application of heat will become a vapor. At the right of this illustration is shown a sectional view of a carburetor. This is what is termed a concentric float type, in which the float surrounds the needle valve. It will be noted that the float maintains the fuel level just slightly below the opening of the needle valve.

In this section, J is the adjusting screw of the needle valve corresponding to the illustration C at the left, in which the needle valve enters the nozzle from the top. K is a lock nut to hold this needle valve tight when adjusted. Air is drawn through the butterfly valve E, which is adjusted by H. E at the bottom of the carburetor is simply a drain for cleaning the float chamber. In the section of the Schebler carburetor shown on the illustration with the vacuum tank, it will be an easy matter to identify the same essentials as those just mentioned. This carburetor also has a concentric float, the needle valve adjustment being indicated by B. A represents an auxiliary air valve, designed to admit increased air through the carburetor in accordance with the increased speed of the motor in order to maintain the mixture in the proper proportion of air and gasoline. The detail at the left shows a device for controlling this auxiliary air valve from the dash of an automobile. An auxiliary air valve is usually only found necessary where there is considerable variation in the speed of the engine as on an automobile.




Section of Schebler carbureter showing travel of air through the main air intake and past the spray nozzle where the air is "carburetted."




Section of a vacuum fuel tank as used on many farm light and power plants for lifting fuel from supply tank to the carbureter.

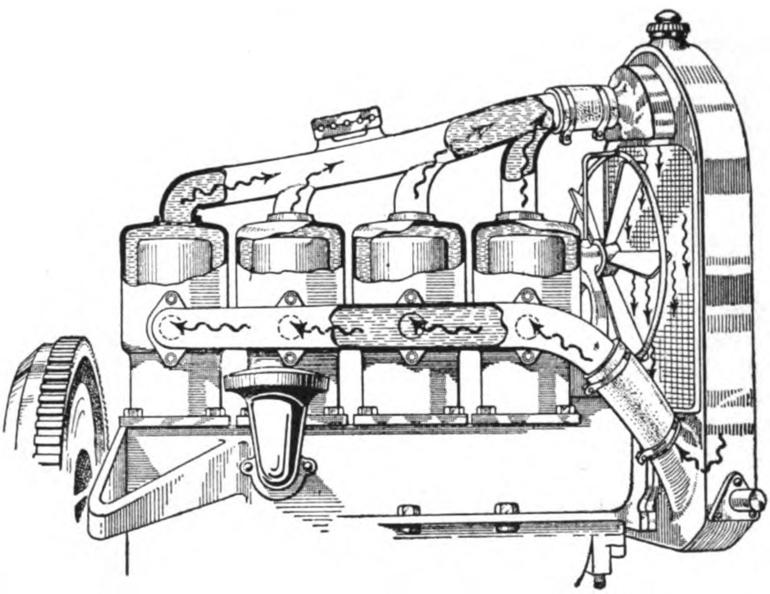
On a farm light and power plant where the engine runs at a uniformly steady speed, this is not necessary. A valve or shutter, termed a "choker," is provided on the main air intake, however, in order that the suction on the nozzle may be considerably increased when it is desired to start the engine. Closing this main air valve increases the vacuum to a maximum and draws a large amount of gasoline spray out of the nozzle, rendering starting much easier.

## The Cooling System

The thermal efficiency of an internal combustion motor of the types used on farm light and power plants probably ranges from about 20 to 26 per cent. This means that out of every 100 units of power represented by a gallon of fuel, 20 to 26 are actually used in the generation of useful power in the engine. Approximately 40 to 50 per cent. of these heat units escape through the exhaust and the balance must be absorbed by the cooling system of the engine. Below a certain size, this is done by air cooling. The cylinder is cast with a large number of thin sections to radiate as much of the heat as possible and the cylinder itself is surrounded with a light metal jacket through which a large volume of air is circulated by means of the flywheel acting as a fan.

Water is used for cooling most farm light and power plants, being circulated on the thermo-syphon principle. Water when heated becomes lighter and rises so that cold water replaces the heated water and a circulation is set up. The hotter the water becomes the faster it circulates and the greater its cooling effect. The system is exactly the same as that employed for heating a supply of water with the aid of the kitchen stove and a small storage boiler, except that the process is reversed, the water being cooled instead of heated.

The details of the cooling system depend upon the size and the number of cylinders in the engine. In the case of of single-cylinder engines two general types are employed, one having a hopper or small tank cast directly with the cylinder and holding sufficient water to cool it. The other type generally used employs a comparatively large tank of cooling water which is piped to the upper and lower part of the cylinder in the usual manner.



**Illustrating travel of water from cooling jacket to radiator and back as temperature changes. This is a Thermo-Syphon system of water cooling.**

While these tanks require more space, they are frequently found to be an advantage for farm use as they provide a supply of hot water in the barn during a season when it comes in very handy. When used for this purpose, the cooling system naturally has to be drained when the engine is not in use to prevent freezing. Otherwise, a non-freezing solution must be used in the cooling system in winter.

On four-cylinder motors, a cellular radiator is employed in order to cut down the amount of water necessary. The radiator divides the heated water up into a large number of very thin streams which are passed through copper tubes so that the air can reach them readily. A fan driven by the engine and placed directly behind the radiator serves to draw air through it. The circulation of the cold and hot water through the radiator, manifolds and around the cylinder jacket is very plainly shown by the illustration, the arrows indicating the travel of the water.

### Lubricating System

As the interior of the engine reaches a high temperature in steady running over long periods, generous lubrication of every moving part is absolutely essential to keep the engine operating satisfactorily and to prevent damage. The lubrication of the average farm electric plant has been simplified to the point where there is usually not more than one oil supply to be maintained. This is in the crankcase of the engine itself. When filled to a certain level, the big end of the connecting rod dips in the supply of oil and distributes it to all of the interior parts of the motor. This is termed the splash system of lubrication and it is also used on four-cylinder motors. There may be an occasional lubricating device of one kind or another on these motors in addition to the splash lubrication in the crankcase, but the latter is the main standby. In addition to maintaining the oil supply at the proper level called for by the manufacturer's instructions, the old oil should be drained off and a fresh supply put in at regular intervals as well because oil loses its lubricating properties after being subjected to high temperatures for a long time and it also collects a surprising amount of dirt. It may also be thinned out considerably by liquid gasoline finding its way down beside the piston into the crankcase. Even more important than the maintenance of a regular supply is the character of the oil itself. The manufacturer of the engine has usually gone to considerable trouble and expense to determine just what grade of oil is required to run his engine most satisfactorily so that his instructions should be followed closely on this point. Never, under any circumstances, should the cheap oil sold for use on agricultural machinery be used in a gasoline engine.

### Ignition Systems

This is treated in greater detail under the heading "Electrical Principles," so that only a brief reference is given to it here. Going back to the diagram showing the cycles of operation of the engine, it will be seen that the spark must occur either just before or just as the piston reaches the upper dead center on the compression stroke, the timing depending upon the speed of the engine. Two general types of ignition systems are employed, one termed the make-and-break, or low-tension system, used generally on low speed horizontal engines, while the second system, termed the high-tension type is used on the higher speed single cylinder engines and on all four-cylinder engines.

In the low-tension system, an igniter is placed in the cylinder. This is a small device carrying two heavy contacts, or electrodes, which are normally together. They are connected in series with a single-wound spark coil, and a battery, or a low-tension magneto which supplies the current. In the case of the battery low-tension system, a contact closes the circuit through the igniter just a moment before the latter is

to fire and the igniter itself is then tripped by a cam. Two types of magnetos are used in connection with low-tension systems, one in which the armature revolves and the other in which the armature oscillates. In the latter, the armature is given a half revolution or more by a cam on the engine and then suddenly released, a strong spring oscillating it at high speed through a half revolution. This supplies the necessary current and is much more reliable and satisfactory than a primary battery. Illustrations of different makes of low-tension magnetos accompany the text.

In the high-tension system, the current, whether supplied by the storage battery or by a magneto, is stepped up to a high voltage in order that it may jump the gap in the spark plug.

This is accomplished by sending the current through an induction coil or step-up transformer, the principles of which are explained in the electrical text. A timer, carrying electrical contacts and connected with the battery, coil and spark plug, is driven by the camshaft of the engine so that it closes the circuit at the proper moment for the spark to occur in the cylinder. In the case of four-cylinder motors, there must be a contact for each cylinder. The four contacts are combined in a unit termed a distributor. which also carries a fifth contact that closes the primary circuit through the coil, while the distributor contact carries the current to the cylinder in which the spark is to occur.

## Some Hints on Engine Care

Knowledge of an automobile, its operation and the care it should be given to keep it running properly has become so widespread that it is hardly necessary to dwell on the necessity for giving the engine of a farm light and power plant the periodical attention that any engine requires, where the lubricating, ignition, cooling and fuel systems are concerned. It is merely desired to point out the overhauling required by the engine in addition to the foregoing and about the intervals at which it should be given. In the course of a year, the engine is apt to be run a great deal more than the engine of the same owner's automobile. While in operation it runs steadily for longer periods at a time and carries a far greater proportion of its total load than does the automobile engine, although it has the great advantage of not being subjected to vibration and jolting.

## Simple Carburetor Adjustments

Bearing in mind that the carburetor is designed to maintain a certain proportion of air to gasoline vapor, it will not be difficult to learn the principles upon which all carburetor adjustments should be made. When an engine does not fire properly and the trouble has been definitely traced to the carburetor (there are lots of engine troubles which appear to be carburetor troubles but are not) following the same procedure every time will bring results quicker. Irregular firing is always caused by either too little or too much gas.

Too little may be caused by a partial obstruction in the jet, in the feed line or in an adjustment of the nozzle that is "starving" the motor. Too much is caused by the carburetor flooding which in turn is caused by a faulty adjustment of the float, a punctured float if it is metal or a water logged cork float. In either case the float has lost its buoyancy and sunk, permitting the gasoline supply valve to remain open. If the float chamber has flooded, cut off the supply from the tank, drain a little off from the float chamber to bring it back to normal level, then open the petcock of the engines and turn it over several times with the battery to clean out the over-rich mixture.

Where regular firing or failure to fire is not due to flooding, adjust the needle valve until the engine runs regularly and smoothly and then very gradually close the gasoline adjustment until the engine begins to misfire

on account of receiving too lean a mixture. Re-opening the adjustment slightly will give the most economical point of operation, but this may not also coincide with an adjustment that gives easy starting of the engine so that it will probably be necessary to re-open the adjustment to a half turn or full turn more. The foregoing refers to types of carburetors having adjustable needle valves. Some carburetors are provided only with an air adjustment and in these types the air is adjusted in the same manner as the gasoline, that is increase the air to a point where the engine begins to misfire showing that the mixture is too weak. Then, turn back to a satisfactory operating point. Space does not permit of going into details of the numerous different carburetors on the market, but it will be found that these principles of adjustment apply to all of them equally well.

All liquid fuel is apt to contain a certain percentage of water and dirt. Both are small in amount, but it takes very little of either to cause trouble. By tightening all adjustments carefully so that vibration cannot loosen them, and filtering the fuel supply into the tank through a piece of chamois, two of the commonest causes of carburetor trouble will be avoided.

### Common Causes of Ignition Failure

The ignition system is responsible for the majority of cases of engine stoppage, but the causes are simple and easily remedied. Taking them approximately in the order of the frequency of their occurrence, they are:

First, spark plug sooting. If too much oil is used in the engine or an over-rich mixture of fuel is being burned, a layer of carbon will be deposited on the spark plug and will short circuit it. Cleaning the plugs with a wire brush and gasoline is a simple remedy.

Second, breakage of the porcelain or other insulator of the spark plug occurs more or less frequently and sometimes is very puzzling because the break does not show and the plug when taken out of the cylinder and laid on it for testing will show a spark as usual. Taking the plug apart is apt to reveal a break in the porcelain.

Third, point burns away. Decreased power and irregular firing under heavy loads will result from the spark plug's points burning too far apart. The plugs should be examined every thirty to sixty days and the points adjusted so that they are not more than 1/32 inch apart.

In the low-tension make-and-break ignitor, failure to fire results most frequently from the sooting and the burning of the contacts. They must be cleaned and filed through at regular intervals, a fine old file being used so as not to remove any more metal than necessary from the contacts themselves.

Leakage of gas around the spark plug or through it will sometimes cause misfiring. To remedy, the plug itself should be tightened up in the cylinder and the nut holding the gasket in the shell of the plug should be tightened up a half turn or so. The outside of a plug should remain perfectly clean in operation, any oil or soot appearing on it being a sign of leakage. To test for leakage squirt a little oil around the shell at the cylinder and around the insulator of the plug and air bubbles will show if gas is escaping.

The next commonest cause of ignition is to be found in the wiring. See that wires are not allowed to become wet or even damp and that they are not bent out of their proper places as this may bring them too near the engine and cause a short circuit in the case of the high-tension connection. When some part of the ignition other than the plug is inspected, take the high-tension connection from the plug and lay it on the cylinder head. Then turn the engine over and if everything is in working order a spark will jump from the end of the high-tension cable. The spark plug itself should then be examined for faults.

Next in order are the contacts of the distributor or the magneto. In all

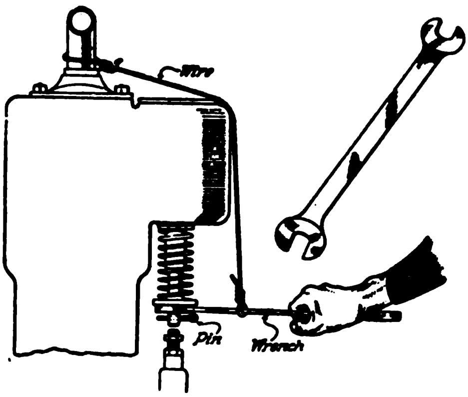
high grade machines these contacts are an alloy of platinum-iridium and they usually give satisfactory service over long periods without attention, but in time the contact surfaces burn away and become pitted and irregular.

They should be smoothed down with a very fine old file, or an old piece of fine sandpaper so as to remove as little metal as possible to true up their surfaces, since they are very expensive. They should then be adjusted so that they separate a little over 1/64 of an inch, the manufacturer usually supplying a special gauge for measuring this distance. Where the ignition current is supplied by the storage battery, the contact will be found underneath the distributor unit. In the case of a magneto they are located in the breaker box on the end of the magneto itself. It is rather unusual but at times the contacts will stick together and they should then be given the same treatment as mentioned above since this sticking is usually caused by the surface of the points having burned away.

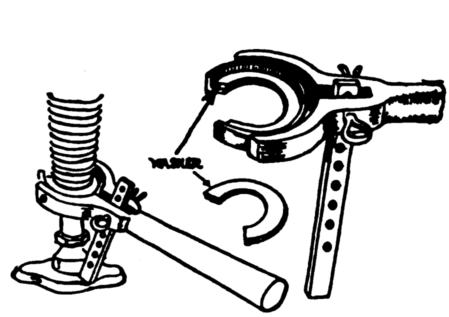
All connections should be kept clean and bright and they should be gone over from time to time to see that the nuts are tightened up. In the case of a storage battery connection, vaseline should be put over the terminals of the ignition connection to prevent creeping and corrosion. Considerable additional information on this subject is given in the section on "Electrical Principles."

### Grinding Valves

The number of times per year that the valves will have to be ground will naturally depend upon the type of plant. In the case of the full automatic type of plant that starts and stops itself and is accordingly in operation a




**One way of lifting valve springs without any special tools.**



**A simple and handy form of valve lifter adjustable over a wide range.**

considerable part of the time, it will be necessary to grind the valves at least once every six months in order to keep the engine in efficient operating condition. On smaller plants, which are not used more than once or twice a week for charging the battery, grinding the valves once a year should be sufficient. While the valves are held on their seats by heavy springs, the gas pressures reached in the cylinder are so high that unless the faces of the valve and of the valve seats are perfectly smooth, there will be a loss of compression and a corresponding loss in power. As the valves are subjected to the very hot gases, they are apt to become pitted or scored.

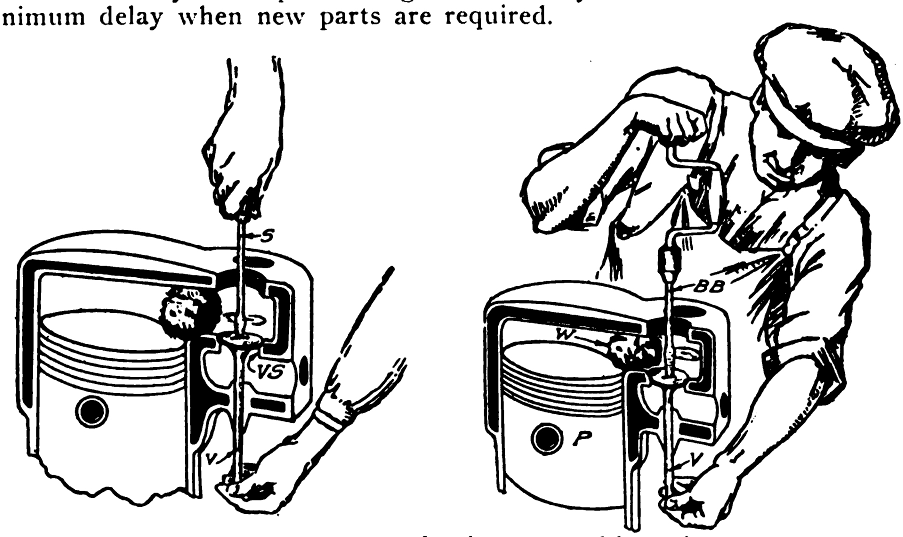
To grind a valve, the spring must be compressed and the pin under the washer released, the accompanying illustration showing one simple method of doing this without the aid of any special tools, while at the right of the same illustration is shown one of the many types of valve lifters to be had on the market for this purpose. As shown in the next illustration it is necessary to put a wad of waste in the valve part of the cylinder so that none of the abrasive material used in griding the valves finds its way into the cy-

linder. Damage may result to the engine unless this precaution is followed carefully; likewise unless great care is taken to wash off all traces of emery after the operation is finished. The illustration at the left shows the use of a screw driver for this purpose while that at the right, the use of a screw driver bit in a brace, the latter being very much handier. The valve is given a half turn back and forth and lifted off its seat at short intervals with the other hand as indicated by the illustration. No more of the grinding compound than is necessary for the job should be placed on the valve seat, as if some of it finds its way down the valve stem it grinds out the valve guide and causes a gas leak at this point.

### Adjustment of Bearings

Whenever a strange noise or knock of any kind develops in the engine, it should be shut down at once and the bearings examined for looseness or play. This should also be done at intervals of two or three months, regardless of whether any noise has developed. The chief bearings to be examined are the main bearings of the engine, that is, those at either end of the crank case and those of the connecting rods. If they show any play, they should be taken up slightly but not enough to bind the shaft. The method of doing this will depend entirely upon the details of construction in the particular engine. In the accompanying illustration, two types of connecting rod bearing adjustment are shown. That at the left is a patented type using a double screw, while the connecting rod itself at the right is a common form of adjustment in which shims are employed. These are very thin strips of metal, placed between the halves of the bearings to hold them a certain distance apart. The adjustment is made by taking out one or more of these shims as necessary and again tightening up the bearings. It's a good thing to go over all of the nuts and bolts on an engine from time to time, since no matter how quietly and smoothly it runs there is always a certain amount of vibration which tends to loosen them.

After a plant has been in service two years or more, it may be necessary to take the engine down and renew some of its parts. More detailed reference is given to this phase of the care of an engine under the heading of "Service," since it involves carrying a stock of parts in order that all of the plants sold by a dealer may be kept running satisfactorily at all times and with a minimum delay when new parts are required.




**Two methods of grinding in valves. Left with a screwdriver, right with a brace and screwdriver bit. Special valve grinding tools which reverse automatically are on the market. Left, S, screwdriver vs. valve slot; V, valve stem. Right, BB, brace and bit; W, plug of waste to prevent grinding compound getting into cylinder.**

# Care of Generators and Motors

BOTH generators and motors will give service over long periods with but very little attention provided the latter is given at proper intervals. Apart from the necessity of seeing that the bearings are kept well oiled, the commutator and brushes will usually be the only parts of the machine that need any attention. Where oiling is concerned, mounted on ball or roller bearings it will require very little, while in the plain bearing type there is usually an oil well holding sufficient to last for a long time, so that in either case the amount of attention required for this essential is very small.

Where the armature bearings are oiled by rings moving with the armature shaft and passing through the oil in the oil reservoirs, care must be taken that the reservoirs do not dry up. The first indication of oil shortage is a tinkling sound resulting from the oil rings running dry around the armature shaft. When the reservoirs are properly filled this sound is completely deadened. Just as soon as the rings cease to carry oil, heating of bearings starts. If the bearings are babbitted, there will be danger of the babbitt melting. If the bearings are of solid bronze, the shaft is likely to bind sufficiently to stop the motor. Improper lubrication may also result from dirt accumulating in the reservoir and preventing the rings from traveling. Oil reservoirs should be drained periodically and flushed out thoroughly with kerosene.

### Brushes and Brush Troubles

When it becomes necessary to install a new set of brushes on a motor or generator the brush holders should first be carefully cleaned inside so that the new brushes will work forward and backward freely. Place a single new brush in position and adjust brush spring tension. Place a piece of fine sandpaper (not emery cloth) about the width of the commutator on the commutator under the brush, with the cutting surface against the brush. Move the paper to the right or left along the curvature of the commutator and in the direction the armature turns until the contact surface of the brush has taken the curvature of the commutator. The paper must be brought well around the commutator, as shown in the diagram. If worked horizontally the corners of the brushes are taken off. Repeat this operation on the other brushes. Only by having the proper area of contact can the brushes be prevented from heating unnecessarily.

Brushes may wear away rapidly from any of the following causes: sparking, glowing, rough commutator, pitting of brush faces.

There are a multitude of causes for sparking at brushes, the more commonly encountered of which are listed in the accompanying chart.

Glowing, which is the heating to incandescence of spots on the face of the brush in contact with the commutator, results from excessive current density over localized areas. Particles of copper lodging on the contact surface of the brush may produce it, or it may result from hard spots in the carbon.

Rough commutator may result from excessive sparking, settling or raising of commutator bars, or wear of bars and projecting mica. Rapid brush wear is the result in any case.

In looking for brush trouble, sparking can usually be traced to one of the following:

1. High mica.
2. Poor brush contact due to gummed up brush holders.
3. Low brush pressure on high speed motors.
4. Brushes shifted out of proper position.
5. Rough commutator (other than projecting mica).
6. Brush contacts not of uniform width.

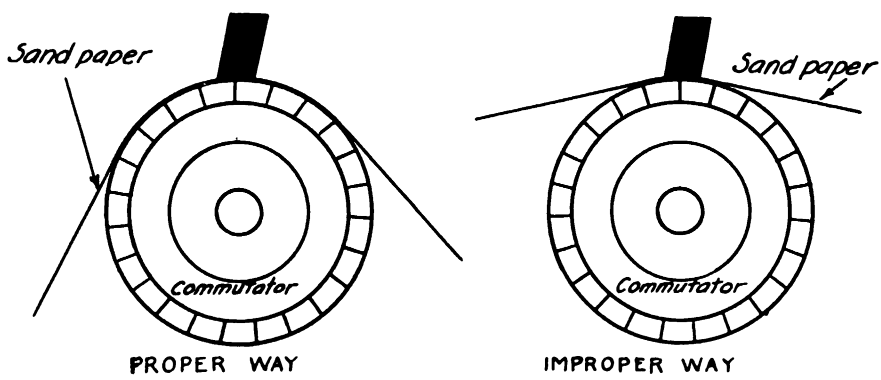
## Cleaning Motors and Generators

It is impossible to prevent oil from creeping upon the commutator bars from the shaft, where it is deposited by the oil rings or otherwise. The oil lodges in the mica between the bars and serves as a first class collector of carbon and copper dust from the brushes and bars respectively. Each of these materials is a conductor of current and when present in quantity is certain to cause trouble, either through the arcing between bars which it promotes or through overloading coils by creating partial short circuits. The most effective remedy against this trouble is cleaning the commutator periodically with a stiff bristle brush and a soft rag with just the trace of oil on it.

Oil and dust collect rapidly in the bottom of motor housings and may produce a "ground" on any field connecting lead resting on the bottom of the housing. Oil which absorbs even the least bit of moisture is apt to cause electrical leakage from any leads resting in it. Wipe out the housing carefully twice a year, at the same time taking note of the condition of binding screws, splices and insulation of leads.

The proper way to correct the rough surface of a commutator is determined by the condition of the commutator. Where the commutator is very rough or eccentric the armature should be taken out of the machine and the commutator turned to a true cylindrical surface in a lathe. Where the commutator is only reasonably rough it may be trued by a commutator stone or sandpaper held in position by a block of wood. The commutator stone is nothing more than a properly curved piece of grindstone—not the black carborundum stone. The curvature in the stone is not absolutely necessary except where the commutator surface is exceedingly irregular. The grinding can be done without removing the brushes from the commutator and during the ordinary operation of the motor under load. If sparking at the brushes is due to poor turning, grinding causes the sparking to entirely disappear. Sandpaper is used in precisely the same manner as the commutator stone with the exception that a block of wood is needed along with the sandpaper to give rigidity to the cutting surface. The sandpaper can be used while the motor is in motion. A fine quality of sandpaper is necessary to secure a smooth surface on the commutator.

Sandpaper may also be used for cleaning commutator, provided a smoothing as well as cleaning is necessary; it should not be used where the commutator has a dark bronze tint and is smooth. A commutator in this condition, and with proper brushes, will give the best of service and will last indefinitely.




**The right and wrong way of sanding brushes in to the commutator. They must bear uniformly over their entire area and be under sufficient spring pressure to hold them against the commutator. If they chatter examine commutator for roughness before increasing pressure.**

# Motor and Generator Troubles

| Symptoms | Immediate Cause | Basic Fault | Remedy |
|---|---|---|---|
| High voltmeter reading; lamps burn with excessive brilliancy. | 1. Too high voltage.<br>2. Same. | 1. Engine speed too high<br>2. Magnetic field too strong. | 1. Slow up engine.<br>2. Adjust rheostat until voltage becomes normal. |
| Low voltmeter reading; lamps burn dimly. | 1. Too low voltage.<br>2. Same.<br>3. Same. | 1. Speed of engine too low.<br>2. Magnetic field too weak.<br>3. Brushes not properly set. | 1. Increase engine speed.<br>2. Adjust rheostat until voltage becomes normal.<br>3. Move brushes clockwise or counter clockwise until sparking is at minimum or has vanished entirely. |
| Ammeter reading above that given as capacity of machine; excessive sparking at brushes. | 1. Excessive flow of current.<br>2. Same. | 1. In case of generator, connected load too heavy.<br>2. In case of motor, too heavy load being carried by it. | 1. Reduce number of lights or motors in operation at one time.<br>2. Reduce load on motor. |
| (3) Armature heats up badly. | 3. Same. | 3. Short circuit or ground in load circuits | 3. Isolate and remove ground or short circuit. |
| (4) One coil of winding heats up more than others | 4. Same. | 4. Coil in armature short circuited. | 4. Remove short circuit. |
| (5) One coil heats up more than others | 5. Same. | 5. Grounds in armature circuit. | 5. Remove grounds by properly insulating coil. |
| (6) Bearings heat up; distinct knock in motor. | 6. Same. | 6. Excessive friction in bearings; armature rubbing against pole pieces. | 6. Clean out oil reservoirs at bearings; make sure oil rings therein travel freely; file off pole tips where armature touches them. |
| Heavy sparking at brushes. | 1. Excessive flow of current. | 1. See symptoms above. | 1. As specified in previous portion of table. |

| Symptoms | Immediate Cause | Basic Fault | Remedy |
|---|---|---|---|
| | 2. Improper setting of brushes. | 2. Brush rocker arm loose; brushes tampered with. | 2. Move brushes clockwise and counter clockwise until sparking is at a minimum or has vanished entirely, and then tighten up rocker arm. |
| | 3. Brushes making poor contact. | 3. Weakened spring; gummed up brush holder not permitting brush to move freely back and forward. | 3. Remove brush, clean out holder with sandpaper; adjust tension of spring; sandpaper brush where it comes into contact with commutator. |
| | 4. Same. | 4. Rough commutator. | 4. Polish off commutator with fine sandpaper on a square block of wood while machine is in motion. Do not use emery cloth. |
| (5) Sparking continues in this case even when armature is slowly turned; there is a flash each time the commutator bar attached to end of open coil passes under brush. | 5. Steady flow of current continually interrupted. | 5. Open circuit in armature winding. | 5. Cut off both ends of the broken coil from commutator and tape them: solder the two commutator bars to which coil was attached together. |
| Heating of commutator. | 1. Brush spring tension too great. | 1. Brush springs adjusted too tightly. | 1. Reduce spring tension. |
| | 2. Heavy sparking. | 2. See heavy sparking at brushes above. | 2. As noted above. |
| | 3. Excessive current. | 3. As noted previously. | 3. As noted previously. |
| Excessive heating of field coils; odor of burning insulation. | 1. Excessive current in field windings. | 1. Short circuit or grounds in field winding. | 1. Repair or rewind the defective coil. |
| Excessive heating of bearings. | 1. Lack of lubrication. | 1. Oil reservoirs empty or oil rings bound. | 1. Clean out oil reservoirs with kerosene; refill with fresh oil; make sure that oil rings travel freely. |

| Symptoms | Immediate Cause | Basic Fault | Remedy |
|---|---|---|---|
| | 2. Shaft does not turn freely. | 2. Bearings out of line. | 2. Line up bearings or rebabbitt them. If small bronze bearings, they may have to be replaced. |
| | 3. Same. | 3. Shaft sprung. | 3. Remove armature and have shaft straightened in machine shop where it can be trued up on a lathe. |
| Low speed; heavy sparking; heating. | 1. Excessive draught of current. | 1. In case of motor, too much load. | 1. Reduce load. |
| Generator fails to generate. | 1. Insufficient field magnetism. | 1. Short circuit or grounds in field windings. | 1. Locate and remove short circuit or grounds. |
| | 2. As above. | 2. Brushes improperly placed. | 2. Shift brushes very slowly while observing voltmeter. Proper location is the point at which maximum voltage is secured with least sparking. |
| | 3. Armature circuit open. | 3. Brushes making good contact; loose terminal connections; broken armature coil. | 3. Clean brushes with sandpaper and adjust spring tension; tighten up terminal connections; locate and repair open coil. |
| Motor fails to start. | 1. Fuse melts. | 1. Too much load. | 1. Reduce load. |
| | 2. Fuse melts; motor hard to rotate without load. | 2. Excessive friction. | 2. See "Heating of Bearings" above. |
| (3) Motor may show signs of strong magnetism, and a heavy flow of current. | 3. Escape of current along useless path. | 3. Short circuit in armature or armature leads. | 3. Locate and remove short circuit. |

# Service and What It Means

SERVICE is at present one of the most abused words in the English language, but no one who contemplates entering this field as a business nor any dealer now in it, can expect to make a success of it without devoting considerable study and attention to the matter of service and at the same time fully making up his mind that he is willing to undertake all that that implies.

Selling farm light and power plants, washing machines, domestic water systems and many of the other appliances that the dealer in this field handles, is not the same thing as running a town or village store. With the exception of small accessories and supplies, the dealer in this field makes very few sales of articles over the counter that are paid for then and there and forgotten. The bulk of his sales are very much larger and the majority of them involve the factor of service to a great degree. These sales consist of machines or equipment and in buying them the customer is buying electric light and power service, water supply service, washing service and the like and not merely so much machinery or equipment. He does not look upon it as the latter at all. He is buying service pure and simple and he does not know the manufacturer, the jobber or the distributor. He knows only the dealer who sold the machine directly to him and he looks to the dealer directly to have his purchase deliver the service for which he has paid.

### Dealer Only Point of Contact

In this way, the dealer is the direct representative of the manufacturer and assumes at first hand complete responsibility for the satisfactory operation of every machine he sells.

This may sound a little hard on the dealer but it isn't as a matter of fact. The manufacturer builds service into his machine, but no matter how well built the machine may be it requires a little personal attention at intervals from someone familiar with its working, in order to deliver that service satisfactorily. Both the customer and the manufacturer look to the dealer. On service and the way in which it is rendered rest the entire structure of the dealer's success. It is the foundation and nothing permanent can be built without a good foundation.

So many have entered this field with the idea that it merely involves making quick sales on large commissions without any necessity of following up the sales and taking care of the plants and appliances, that when they were called upon to take care of the plants, they gave up the business in disgust. To listen to some of their tales of woe, it might appear as if they were entirely justified, but this is not the case by any means. In one particular instance a dealer complained that one of his customers made him drive ten miles on a stormy night and the trouble turned out to be nothing more than a dirty spark plug which the customer himself could have remedied in five minutes, or far less time than it took him to telephone the dealer. This is an extreme case, of course, but there are plenty like it and there will be thousands more that are equally bad, but if he is going to make a success of his business, the dealer must look upon them all as a part of the day's work.

### Customer Unfamiliar with Electricity

If instead of being a farm light and power plant of the direct connected type, the case above mentioned had been merely a stationary engine, the customer would have set upon remedying any trouble with it without ever thinking of telephoning the dealer. He would have found the dirty spark plug in a few minutes, cleaned it or replaced it and thought nothing more of the occurrence. But when the farm light and power plant refused to operate properly, he never thought of such a simple thing as a spark plug being at fault. His lack of knowledge of electricity led him to believe that

there certainly must be something wrong with the electrical end of the plant and he did not want to tinker with it for fear of doing damage. But it is quite certain that the same customer will not ask the same dealer to drive twenty miles again simply to fix a spark plug so the dealer may put the experience down as that much education given this particular customer.

There will be thousands of cases in which customers will ask the dealer to go out of his way to service the plant for an equally piffling case and, if the dealer is going to make a success of his business, he will give all his customers the service they require on every occasion, putting it down to education whenever it proves to be some trifling cause that the customer might just as easily have corrected himself in a few minutes.

### Real Service Clinches Customers' Good Will

To get and keep the good will of all his customers so that they will come to him whenever they are in the market for anything else, the dealer must not only admit but actually encourage their impression that he is responsible from beginning to end for the satisfactory operation of every unit that he sells them. As a matter of fact he is, because where the trouble cannot be corrected by a little personal attention and adjustment, but proves to be some defective part, the customer looks to the dealer to have the manufacturer make good and that is one of the dealer's duties. It is naturally exasperating to have to give up a great deal of valuable time driving around the country to wait on customers whose complaints are not merely trifling but sometimes wholly unwarranted, but it must be done. It is up to the dealer to educate these customers of his in the operation of the plant and appliances to a point where they are just as familiar with them as he is and there is no better time to drive this educational process home than when he is calling on the customer to correct some trifling matter that the customer could have attended to himself equally well.

### Service Calls Good Sales Opportunities

No matter how trifling these complaints are, the time devoted to them should not be put down as lost by any means. They afford the best possible opportunity for talking new equipment and appliances and for making demonstrations, because they come at a time when it is possible to interest the entire family and to gain concentrated attention which would not be forthcoming on a call that had been made for sales purposes only.

Call them what he will, the wise and progressive dealer will spend more of his time in thinking up ways to capitalize these calls instead of putting it all in cussing the plant owners who are complaining about such very trifling things. Unless the dealer is more than willing to consider a service of this kind simply as part of the day's work, to be rendered cheerfully at almost any hour of the twenty-four, he is going to find it mighty difficult to make a success of the business. On the other hand, by giving this kind of service regularly to every customer, he will build up an amount of good will that could not be obtained in any other way and the good will of his customers will prove to be one of his most valuable assets. Let him once gain a sound reputation for reliability and service and he will make a far greater success of selling second rate plants than the dealer who does not believe in giving 100 per cent. service to his customers can ever make with the best line of plants and appliances on the market.

Study your plant and every appliance you sell carefully and become so familiar with it that you know them inside and out. Then you will always be in a position to tell right off hand what is the matter with it when it is not working satisfactorily. There are a lot of little things to learn in this connection but it will pay every dealer mighty well to master them so that he comes to be generally regarded in his territory as an authority on electrical matters.

# Carry a Stock of Replacement Parts

It goes without saying that no dealer should contract to represent a manufacturer and sell his plants or appliances, until he has studied them himself pretty carefully and made up his mind that they are the kind he is willing to sell and stand behind. When he has done so, then he should be willing to give 100 per cent. service and a little more of everything he sells.

One of the most important points in rendering service is the ability to replace a broken or worn part, because it doesn't do the owner of a dead machine much good to have the dealer tell him "I have to send to the factory for a new part and it will take two or three weeks to get it." Frequently, in cases of this kind, the owner knows just as well as the dealer what is wrong with the machine because the part has either broken or has worn so that it is easy to determine the cause of trouble. What the owner needs most is a new part that the dealer ought to be in a position to bring it out with him when the customer sends in the trouble call. Every machine built has some parts that are subjected to the most severe service so that no matter how well they are made, the very nature of their operation causes them to wear out more or less rapidly. Typical instances of this are the brushes on motors and generators and the valves and valve springs on the engine. In order to be able to render the proper kind of service the dealer must accordingly count upon carrying a fairly comprehensive stock of replacement parts not only for his plants, but also for every one of the appliances that he sells, such as washing machines, water systems, milking machines, churns and the like.

### Spare Parts for Engine and Generators

As his entire business is based upon his plant sales to a very great extent, the dealer must naturally regard the plant as the most important and go to a greater extent in supplying spare parts for the engine and generator than he would for other machines since it is not so serious to have the latter out of service temporarily. In the case of the engine, he should lay in a stock of valves, valve springs, valve tappets, cotter pins, washers and the like since the valves get very hard wear. He should also have on hand several ignition unit replacements such as contact points, timers, timer parts, coils, distributor units, or magnetos, depending on the type of ignition system that his plant carries. The question of replacement parts and service in this connection should be carefully talked over with the manufacturer's engineering department and a list of the most necessary parts together with the quantities made out at an early date. The most perfect machines ever built will sometimes go wrong before they have been in service for more than a few weeks and it is usually only a question of replacing some small part. If the part is right at hand so that the machine can be kept in service without a break, it will be a great help for the dealer whereas if it is going to be necessary to wait a week to three weeks to get that small part, it is going to make a very bad impression on the new customer just at a time when bad impressions are most serious. Consequently, it is very necessary that this stock of replacement parts be put in by the dealer before he has gone very far. It is very natural to put off a thing of this kind under the impression that no parts will be necessary under a year or two and then to find out that a great deal of annoyance could have been prevented and good will gained if the parts had been stocked at the start.

In addition to the valve and ignition elements for which replacement parts will be needed, extra bearings should also be carried in stock since some customer is bound to run his engine dry sooner or later and burn out his bearings. He may be so delighted with the electric light and power that he is getting that he forgets to keep up the oil supply so that there is a breakdown within the first two or three weeks. Piston rings, wrist pins,

one or two spare pistons and connecting rods will be found valuable sooner or later.

### Generator Replacement Parts

In addition to the parts already mentioned as necessary to keep the engine running properly and give satisfactory service, there will also be some that apply to each particular engine and these can only be determined after consultation with the manufacturer's engineering department as mentioned above. Get what you need of a complete list. If they are not used, you can send them back to the manufacturer and get credit for them, but sooner or later you are going to have a call for one or more items in your entire list. This applies to the engine itself.

Where the generator is concerned, it will only be necessary to lay in a stock of brushes, brush holders and brush springs to take care of most of the demands for service on the electrical end. You must have these and you must be careful to see that none of your customers use brushes of any other manufacturer than those supplied by the maker of the plant because trouble is bound to arise from that cause if you don't. To take care of real emergencies, when you have a number of plants out it will be worth while to carry a spare armature for the generator so that if one burns out in a customer's plant, you can replace it with your service armature temporarily while you send the damaged one back to the factory for repairs.

A book of several hundred pages could be written on "Service" without exhausting the subject. There are hundreds of ways in which the dealer can benefit by always being ready to keep his customers' plants in A1 running condition, but space does not permit of going into detail here. They are treated from month to month in the pages of Farm Light and Power.

# How to Wire Buildings*

HAVING entered this field with a view to establishing a permanent business, one of the questions the dealer must settle for himself is whether he is going to be content to remain merely a sales agent or whether he will dig in himself and reap the profits to be made in every branch of the business. His first idea must be to sell electric service, and to do so he must guarantee to deliver a complete installation ready for working. This means planning and installing the wiring. It is strongly recommended that every dealer study this part of the work closely, so that he knows thoroughly how it should be done, whether he actually does the work himself or not. In his early days it will be excellent experience to do this work himself. As his business grows and his time becomes more valuable in selling and directing the sales end, he can employ an assistant who has gained his experience with an electrical contractor. The dealer himself will then be in a position to lay out plans for wiring installations and to pass on the jobs after they have been done.

### Estimating the Supplies Needed

As there is no need to wait for the arrival of the plant before beginning the wiring, the first thing to do is to settle the location for the outfit and where each light is to go. This is necessary in order to figure up the necessary quantity of wire, insulators and sockets.

Take as an example the wiring of a two-story house, eight rooms with a cellar and attic. The plant is to be placed in a room in the barn, 100 feet from the house.

There is to be one light in the attic, four lights upstairs, five lights downstairs and one light in the cellar. The light in the attic and the light in the cellar are each to be controlled by a switch placed near the attic and cellar stairs. The other lamps are held in key sockets which have self-contained switches.

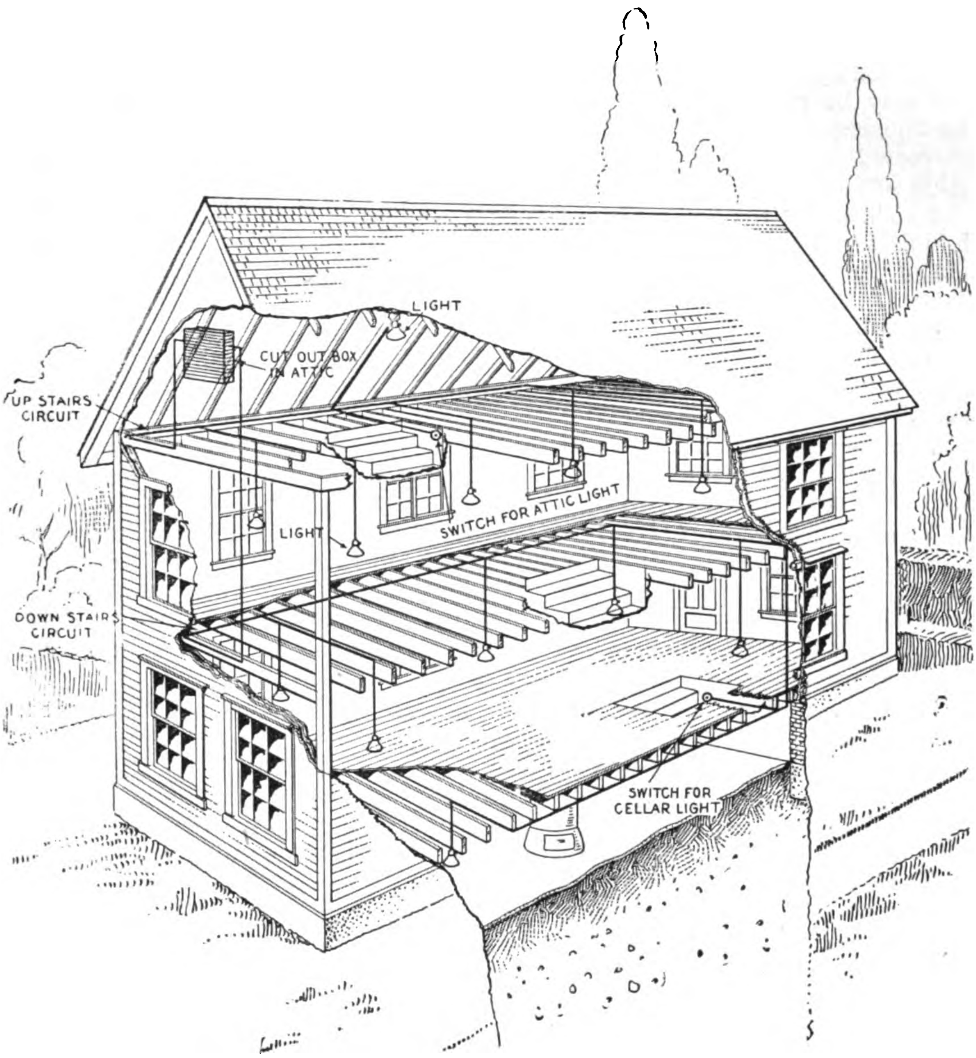
There are always two copper wires running to each lamp or switch. (See "Circuits" in Elementary Principles of Electricity.) These copper wires are insulated by coverings of rubber compound and cotton braids, and are then held firmly on porcelain insulators as shown in the illustrations, or enclosed in iron pipes. Insulation is necessary to prevent accidental contact between bare metal surfaces carrying electric current, owing to fire danger and danger of damage to the apparatus.

There are several systems of wiring: one in which the insulated wires are protected throughout by iron pipe or conduit and iron boxes; one where the wires have an outer protecting armor of steel tapes; one where the wires are enclosed in flexible woven tubes (such as circular loom); and others where the wires are attached to porcelain insulators on the outside of the walls or enclosed in mouldings nailed to the walls.

Selecting for this example a combination of several of the latter systems, we decide to run the wires on porcelain insulators in the attic and cellar, enclosing the wires in flexible woven tubing (circular loom) inside the walls and flooring in the middle of the house wherever insulators are hard to place. It is most convenient to make a rough diagram or plan of each floor and mark where the lights are to go.

The supply mains or two wires from the plant in the barn will enter the attic, and each will, therefore, be as long as the distance from this point to the place where the outfit is to go plus a few feet for convenience in making connections. As the plant is to stand near the wall where the wires enter, allow say six feet on each wire inside the building holding the outfit

* Illustrations and text courtesy Western Electric Co. Publicity Dept.




**Section of house showing the lights and wiring. The wires from the battery enter the switch box in the attic from outside (but are not shown). One circuit from the box controls the upstairs and attic light. Another circuit controls the downstairs**

to reach to the switchboard, and two feet on each wire inside the attic to reach to the box holding the service switch. This makes 108 feet for each wire, or 216 feet in all, of triple braid weatherproof wire No. 10 B. & S.

Next measure the wire needed for the inside wiring in the house, either using the plan or going over the actual walls and floor with a tape line or rule. It will be found better to divide the house wiring into two parts or circuits, for example, one for the upstairs and the other for the downstairs lights.

One pair of wires will then be run in the attic from the service switch passing as near each light on the top floor as convenient.

"Another circuit controls downstairs and cellar. The upstairs circuit is run open above attic floor on roof rafters or skirting. The downstairs circuit is run between ceiling and floor above, floor parts being bored and tubed."

The individual lights or fixtures will be connected to wires joined or "tapped" on to the same main current wires.

As it is assumed that the attic is not fully floored, it will be easy to run the upstairs circuit on the floor joists, of course below the floor line, which will probably bring the wires actually over the ceiling lights. Some wires also may be run inside on the roof rafters. On the floor below, parts of the flooring will be opened and the wires encased in flexible loom pulled between the floor and ceiling, and also held on insulators over where the lights are to go.

As shown in the diagrams, it is easier to plan so that the wires run with the joists. Where they run at right angles to the joists, that is, in the direction of the floor boards, each joist must have holes bored in it, in this case about 11/16 inch in diameter, and the holes bushed with porcelain tubes, as shown.

The first thing then to do when estimating the wires and supplies is to mark where each light is to go. For wall lights mark a pencil cross on the walls.

For the lights that hang from the ceiling it is better to take a long thin bit, say a bell hanger's wood drill bit, No. 6, at least 18 inches long, and bore clear through the ceiling and the floor above.

The holes in the upstairs floor boards will form guides for opening the flooring. The amount of wire and flexible loom may now be found by measuring with a tape line or rule over the route the wires will take. Allow enough wire. If any ends are left over they will come in handy.

As most of the wires can be run on porcelain insulators or split knobs, about 50 feet of ¼-inch circular loom will be required.

To support the wire, fifty No. 5½ standard split knobs will be needed, and to bush (or insulate) holes through which the wires pass 100 porcelain tubes 5/16-inch hole and 4 inches long.

Nails and heads (small pieces of leather slipped on the nails which fasten up the knobs to prevent breaking the porcelain) can usually be found on the farm. Or the knobs may be held by flat head wood screws, which require no leather protectors.

A roll each of insulating tape and splicing compound will be necessary to wrap wire joints, together with some solder and a soldering stick or can of soldering paste.

Outdoors, a dozen 12-inch wood brackets and a dozen No. 17 glass insulators will be used.

Where the wires from the plant come into the attic through holes bushed with porcelain tubes, they are first connected to a fuse-block or cut-out and then to a switch. The purpose of the fuse-block is to act as a safety device should the wires in the house become overloaded. In this case, a piece of soft metal (fuse) held in the fuse-block will melt and act like a switch, breaking the electrical connection between the battery and the danger point.

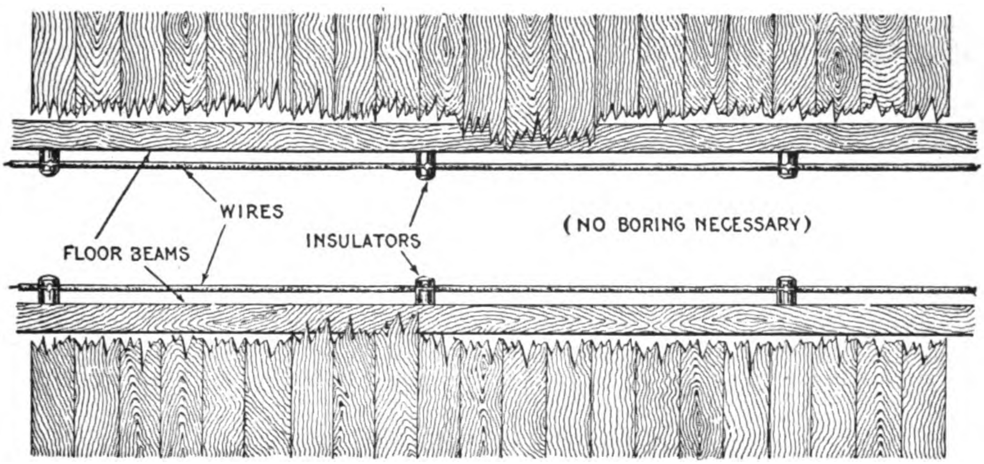
It is preferable also to use another fuse-block on each of the house circuits. It is convenient when changes in wiring are being made, as only part of the lights need be turned off. See "Protection of Circuits."

These fuse-blocks and the switch are to be enclosed. A wooden box lined with asbestos and provided with a tight fitting cover may be used, as shown several pages further along. It is preferable, however, to use a sheet steel box made for the purpose, which then needs no asbestos lining. One, in this instance, 8 x 14 inches and 3 inches deep will answer.

For installing the lights the present plan calls for two single pole snap switches, one for the attic light and the other for the cellar or the

porch light. Eleven complete drop lights will be needed, each consisting of a porcelain rosette, a key socket already bushed, 2¼-inch shade holder, and enough cord to let the lamp reach six feet six inches from the floor.

The drop light in detail is shown a little further along. If fixtures are




**View looking down at floor beams, floor boards shown broken away. Wires run with the beams**

preferred, these as well as lamps and shades, may be selected according to the requirements of each light.

Next, run the wires. The wire will come in coils, and it is preferable to use it always from the inside of the coil, as it is less liable to kink.

### For the Upstairs Circuit

The wire is laid in the groove between the cap and the base of each insulator, pulled tight, and the nail or screw driven home. It is not necessary to have the wire extremely tight, but it is to be held so that there is no danger of it becoming loose and touching against woodwork, metal or pipes. Where wires cross each other, cross pipes, or pass through holes, they are to be encased either in a piece of loom, or porcelain tubes are slipped on and held by winding of friction tape.

Start wiring from the attic and wire in between the floor joists so as to come as close as possible to each light in the room below as shown by the holes in the ceiling. The main wires only pass near or above these holes; separate pieces of wire are tapped on to actually pass through the holes to the lights.

Where there is no flooring, insulators are easily placed in the floor beams about every four feet, a few inches below the top, as shown in the diagrams. Where there is flooring, it generally becomes necessary to take up pockets (that is, cut out a piece of board between two joists) at the places where the insulators are to go. The pieces of board are afterward replaced. The wires on a long run may also be enclosed in circular loom, in which case they are simply pulled under the floor.

### The Downstairs Circuit

Having run the main wires for the upstairs lights, do not yet make the actual connections to the lights, but first finish the rough wiring by running the downstairs wires.

As the bedroom floor is boarded, it will be necessary here to first cut out the pockets in the floor or take up the boards and bore and tube the holes where the wires must run through the beams.

The circuit of two wires will run from the box to the attic, down in the wall to the bedroom floor, as shown in the illustration on a previous page, then along between the joists to a point in line with most of the lights. Here boring and tubing become necessary. The circuit will then go through the tubes and continue across the house between the joists, then down in the wall, and finally to the cellar light and switch.

Any lights on the other side of the house from the main wires are reached by wires run between the joists, but tapped onto the main wires as shown. This saves much boring and the expense of porcelain tubes.

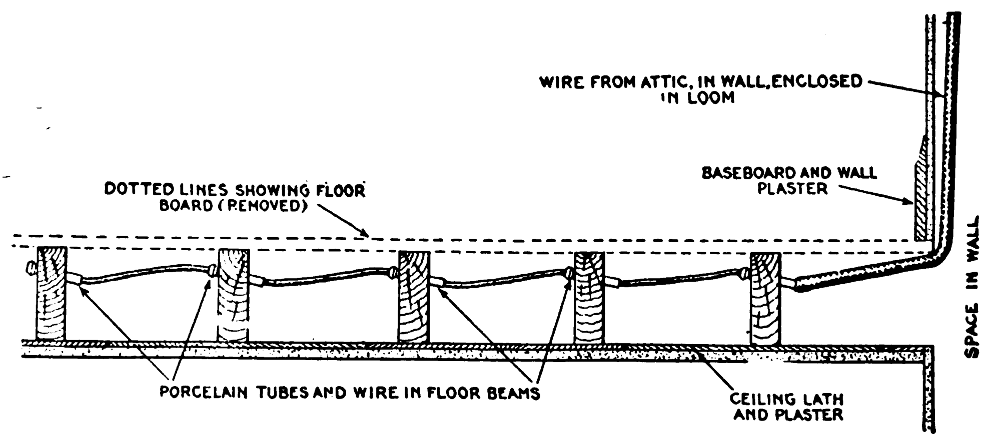
Where the wires run inside the walls encase them in circular loom, each wire in a separate piece. This is measured and put on before the wires are pulled downstairs. A piece of chain or a lead sinker attached to a length of fish line may be first dropped down in the wall, its end located downstairs by listening at the baseboard, and a piece of the latter removed, and the fish line used to pull down the wires, which are first attached to the upstairs end.

## Connecting Lights with Switches

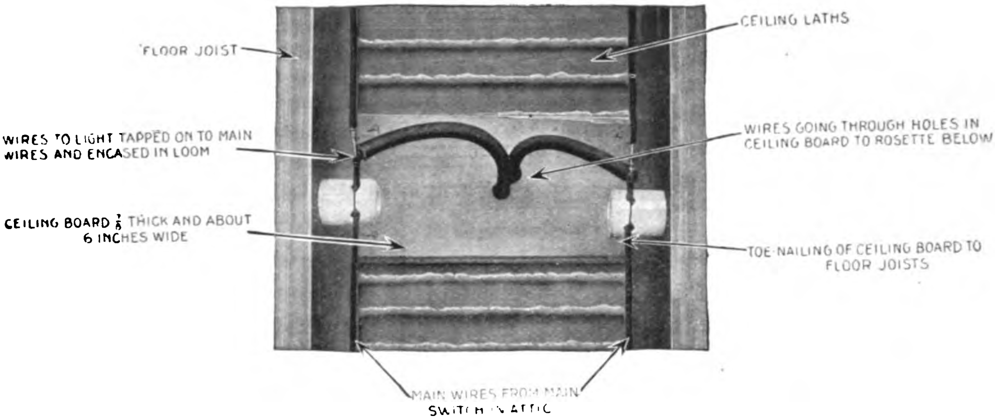
Where the switches are to be put on, as in the case of the cellar light and the attic light, run only one wire to the lamp but the other wire to the switch. Then run a piece of wire from the switch to the lamp. The switch is to be connected, as shown in the illustration, to the two ends—one from the main circuit, the other from the lamp. The lamp will be connected to the other circuit wire and to the wire from the switch.

Having finished running the wires and fastened them all tightly under the split knobs, join on short pieces of wire to reach down through the holes in the ceiling to the rosettes and enclose them also in circular loom, as shown in the illustration.

Although the ceiling rosette or fixture may often be screwed fast to a ceiling beam, it is better to nail a piece of board as shown, between the joists right over the ceiling plaster. This will hold the rosette screws which will go clear through the lath and plaster into the board and hold up the rosette or fixture.




**Section of floor showing an example of one wire coming down inside wall and through floor beams. Also showing the boring and tubing necessary when wires are run through floor joists. Can often be avoided by planning**




**View looking down through hole in flooring showing how to wire an outlet for a drop light or fixture**

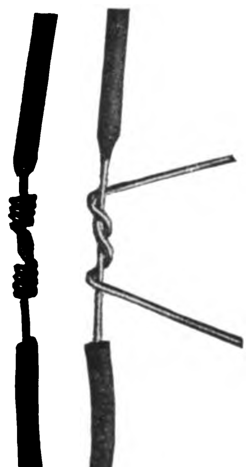
### Make Good Joints at All Connections

In joining on the short wires, the ends for about three inches should be bared to the copper and scraped bright. The rubber covering on the main wires is also cut away and the copper scraped bright for three inches. The short ends are then tightly twisted around the bared spot in an open spiral, as shown in the illustrations.

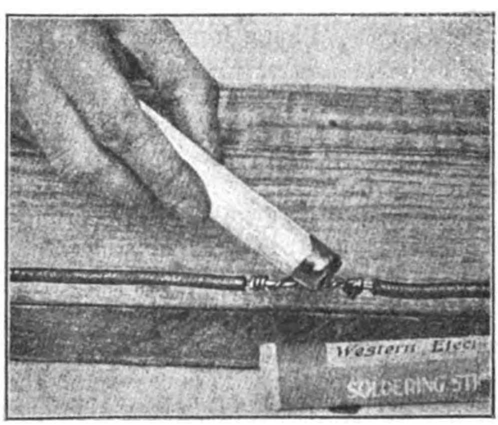
It is best to have all joints open, and solder them all at one period to save time and labor. Soldering a joint is a simple process, when good material is used and the directions are followed. First, the copper wires must be scraped clean and bright. When during manufacture they have been first given a coating of tin, this coating is not to be scraped off, but only cleaned.

Then the joint is heated in a smokeless flame, such as that from an alcohol lamp or a gasoline blow torch. A copper is seldom used, as it chills too quickly. The gasoline torch is suitable where only an hour or so of soldering is to be done. These torches operate by compressed air, which is pumped in and forces the gasoline or kerosene out under pressure.

The small torch has no air pump but the pressure is kept up through a rubber tube from the user's mouth.



**How to make a splice joint**



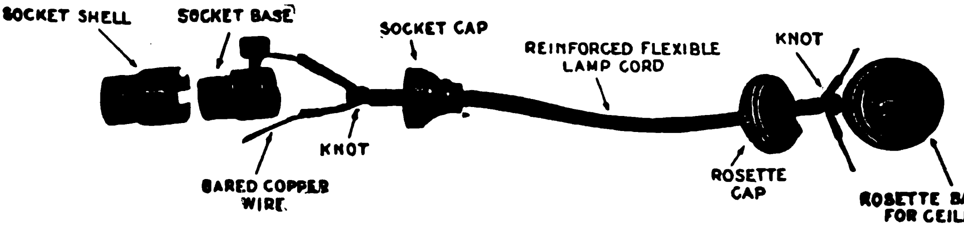
**Fluxing the joint with the soldering stick**

Thrust the joint in the torch flame or apply the flame to the joint for a few seconds, remove the flame and apply the soldering stick so that some of the compound melts and runs in the joint. Then put it back into the flame and rub it with the stick of solder, which should flow into the turns of the joint. The two things to watch are, not to get the joint and compound so hot that the copper burns, which is shown by the flame getting green, yet be sure that the joint is hot enough for the solder to flow freely.

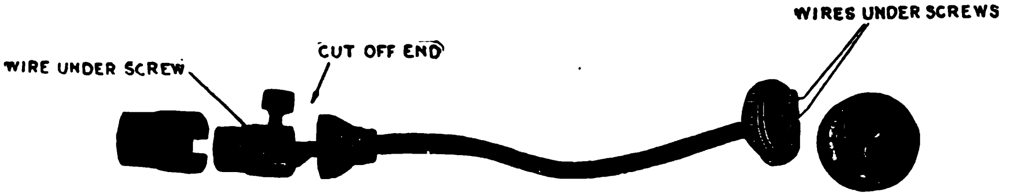
While the joint is still hot wrap a piece of splicing compound on it, kneading the compound in, when it will stick; then wrap the entire joint and compound with friction tape.

In the present case it is assumed that the lamps will hang from the ceiling, as shown in the illustration of switch wiring. This is the simplest and lowest priced lighting installation. Where fixtures are used, the two wires of the circuit are simply spliced and soldered to the wires of the fixtures and insulated.

The ends of the wires coming down through the ceiling are thrust through the holes in the bases of the porcelain rosettes (which separate into two




How to make up a drop light




Copper wires in the cord fastened under screw in socket and rosette, spare ends left for convenience in working are now cut off up to screw

parts) and the latter screwed fast to the ceiling. The ends of the wires coming down through the ceiling and rosette base are then bared and scraped bright for an inch or so, then fastened under the screw clips in the rosette base; in all cases bending the wire once around the screw in the direction the screw tightens. After tightening screw, cut off spare ends of the wire.

You will notice that the smaller end of some sockets has a threaded hole at the end and a set screw at the side. The set screw is to be loosened and a rubber bushing screwed into the large threaded hole to keep the flexible cord from chafing. The set screw is intended to secure the socket when screwed on a metal fixture.

The lower part or cap of the rosette, the cord and the socket, are connected up as shown in the illustration. When ready, the cap with its cord and socket is pressed up against the base and given a turn when it will catch and remain fast.

In baring flexible cord, it is preferable to bare several inches, twist the strands together and after fastening under the screw, cut off the spare ends. It is good practice to dip the stranded ends of flexible cord in molten solder. Where this is not done care must be taken to see that all strands of the wire are clamped under the screw and no loose ends left sticking up as the latter will cause short circuits that are puzzling to locate. The spare ends

give a hold to the fingers to assist in getting the wires tight under the screws.

A knot is made with the two insulated cords, as shown, to take the strain off the screw connections. This knot is made at each end after the rosette cap and the socket cap with its hard rubber bushing have been threaded on the cord.

Reinforced cord has two rubber compound insulated flexible copper cords held together by more rubber, making one round cord with a cotton or silk braided covering. The braid and the joining rubber compound are cut away only sufficiently to enable the two inside wires to reach to each connection; the braided and rounded cord is left intact at the holes in the caps. A few turns of thread around the end of the cord will prevent the braid unraveling. It must be understood that the flexible wires must still carry their insulation where the knot is made or the bare wires would be in contact.

### Building the Outdoor Line

Where the distance between the barn and the house is longer than about 100 feet, or where it becomes necessary to avoid a tree or another building, poles may be used to carry the wires on brackets and insulators, as shown.

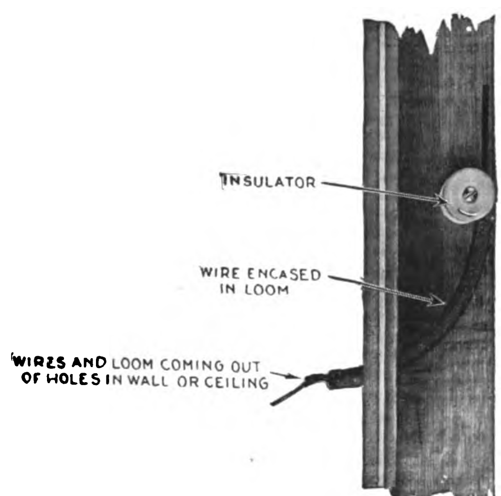
In order to avoid unnecessary strains it should be remembered that a copper wire stretched very tight in summer will tighten much more in cold weather, therefore the degree of tension on the wire should be gauged according to the temperature the day it is put up.

First, the two holes for the tubes are bored about a foot apart, slanting upward, through the attic wall and the barn wall. Then an oak bracket is nailed on just above each of the holes and a glass insulator screwed on each bracket.

Starting at the highest point—the attic—the wires are made fast to the insulators. Ends long enough to reach the switch box are thrust through the holes, the porcelain tubes being put in from inside the building are put in when convenient. Then the lower ends of the wires are made fast to the insulators outside the barn, care being taken that at no point does any part of the wire touch anything except the insulators or tubes. Finally, the ends to reach the switchboard are pushed through the holes or through the porcelain tubes if the latter are in place.

In the present example, the only outdoor wiring is that from the barn to the attic of the house. The wire recommended for this outdoor line is No.

END OF COPPER WIRES IN CORD TWISTED AROUND SOCKET SCREW WHICH IS TIGHTENED. SPARE END IS NOW CUT OFF




**Showing how the ends of a wire run on insulators is to be protected by a piece of loom starting from the last insulator.**

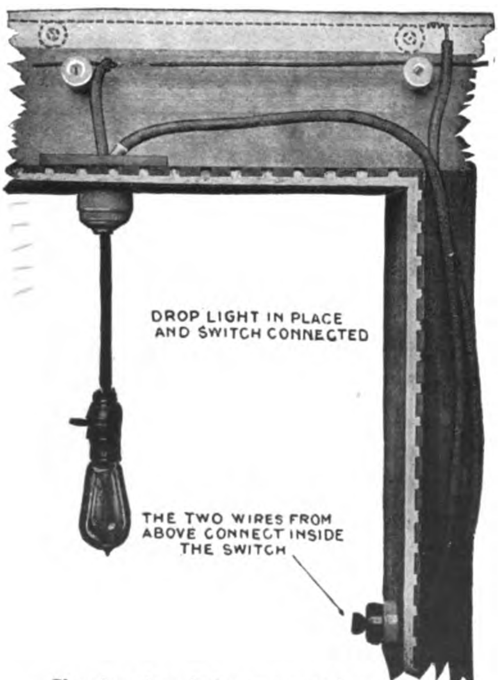
**Connecting wires to screw terminals**

10 B. & S. triple braid weatherproof copper wire. This is larger than the wire used indoors, for several reasons. First, it must carry all the current that flows from the battery, whereas the house wires are in two circuits. Then it is larger because of the distance it carries the current. Just as in the case of a water pipe, the longer the distance the water is to be carried, the larger must be the pipe to avoid loss of pressure from friction. The wire is larger also for other reasons, such as wind strains, as it is swinging free in the air, and also on account of the weight of ice or snow, which it may gather in the winter. Outdoor lines should clear all roofs by 8 feet to avoid injury during sagging or swinging.

## Summary of Supplies Needed

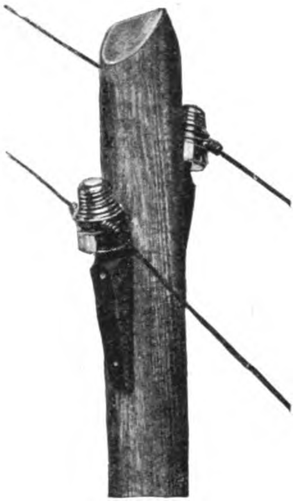
This is a summary of the supplies needed to wire the house described in the example, and is applicable to that example only.

216 feet No. 10 B. & S. weatherproof copper wire.
250 feet double braid No. 12 R. C. copper wire.
50 feet circular loom ¼ inch.
50 No. 5½ standard split knobs.
100 5/16 x 4 inch porcelain tubes.
6 5/16 porcelain tubes long enough to go through house and barn walls.
Porcelain bushings for iron box.
Nails and leather nail heads.
Splicing compound and insulating tape.
Solder and soldering stick.
12—"12 inch" wood brackets.
12—"No. 17" glass insulators.
1 steel cutout box, 8 x 14 x 3 inches, completely equipped for two circuits.
2 S. P. switches, No. 2001.
11 drop lights consisting of No. 7407 sockets and holders, No. 298 Junior rosettes, reinforced cord.

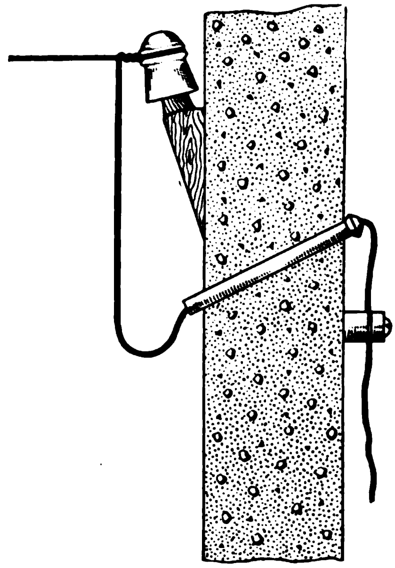



Showing drop light and switch complete.

**Method of installing pendant or "drop" in connection with a switch. While shown close to the lamp in the illustration, the switch may be placed a considerable distance away, as to control a cellar light, a barn light or an outdoor fixture.**



Pole line and insulators



Showing how to run outside wires into a building

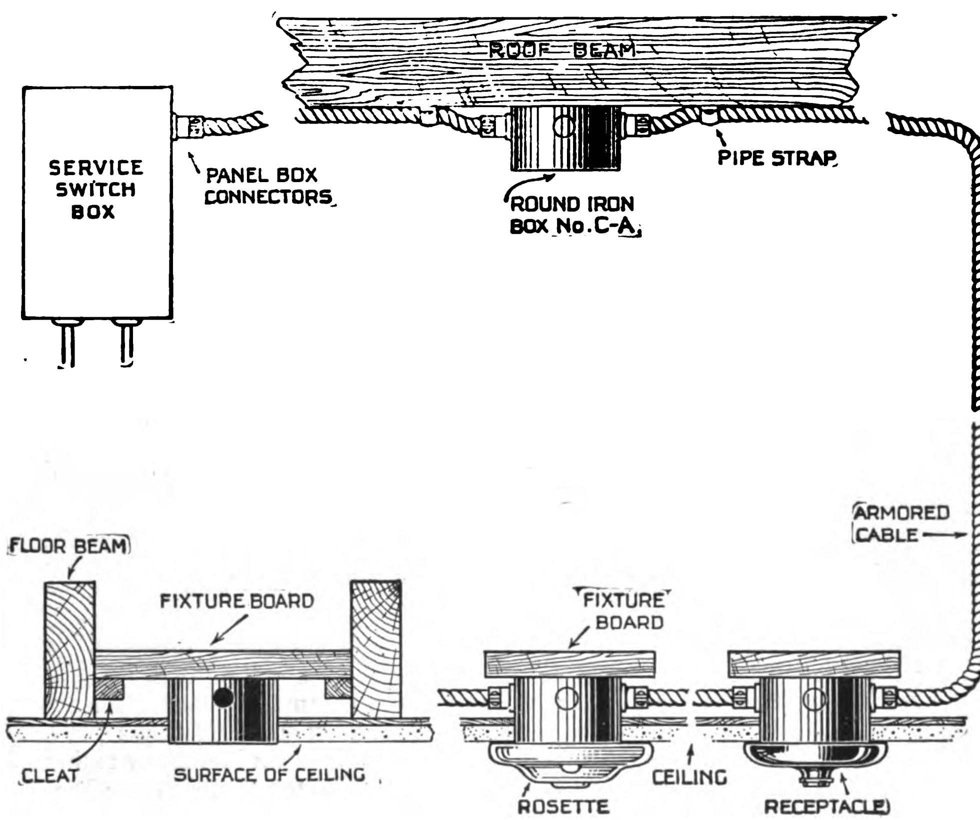



Diagram of wiring with armored cable and sheet steel boxes

# Conduit and Armored Cable Wiring*

THE safest and most satisfactory way to wire a building is to enclose the wires in the class of iron pipe known as conduit. Where this rigid pipe is used, it is installed first, together with steel boxes or the fittings called condulets, in either of which splices, taps or connections are to be made.

Then the wires are drawn in and the necessary connections made. Flexible conduit made of steel tape is also used as a protection for wires, but is not absolutely moisture-proof as a properly installed system of pipe or rigid conduit will be.

Conduit wiring calling for pipe cutting, threading and very exact measurements will not be described here.

Armored cable provides a safe method of house wiring, either for the entire house or for main lines only. It consists of two insulated copper wires protected by a spirally wound strip of galvanized steel. These steel armored wires are pulled in under floors or in walls where electric light wires are necessary and need no further insulation. Armored cable is extremely safe and convenient and saves the labor of opening floors, to set insulators and the cost of tubes, knobs and similar items, as it is easily fastened in place with ordinary pipe straps.

This diagram shows how armored cable is used. Here it is shown starting at the service switch where the electric current comes from the plant or pole line, along a beam, and thence down under a floor and just above a plastered ceiling.

Either a wood or steel box containing the service switch may be used, but a special steel cabinet with safety switch, which is a complete box and switch combined, is preferable.

The wiring on the roof beam may also illustrate how armored cable may be run in a barn or stable.

In the lower part of the diagram the cable is shown entering and leaving steel boxes set flush in the plaster ceiling. Details of the fixture board are also shown both across and end-ways, with the wooden strips or cleats holding the ceiling board up so that the box sets flush with the ceiling below.

Armored cable is led into steel boxes or into cast iron fittings called condulets and connected or spliced inside these boxes or fittings. This steel armor and the iron fittings are what make this wiring system both convenient and safe.

### May Be Used with Special Fittings or Steel Boxes

Although the cast iron fittings, such as the condulets, are most convenient and make a first-class job, a perfectly satisfactory installation can be had by using sheet steel boxes with the armored cable.

The sheet iron boxes are provided with holes temporarily closed by discs of iron called knockouts, because they are knocked out wherever a hole is needed.

Suppose, now, that a length of armored cable is being run under the flooring and is being pulled along by means of a wire or piece of cord and left lying straight as possible to economize cable.

Where the cable is to enter the service box, a knockout is driven out by a blow of the hammer and the threaded end of a box connector inserted. A check nut is screwed on the connector inside so as to clamp it tight in the side of the box, and then a bushing is screwed on to leave a smooth surface for the wires to pass over. (Some types of fittings do not require bushings.)

The end of the cable is stripped of its armor for about six inches, or rather more than long enough to reach the cut-out or switch terminals in the box.

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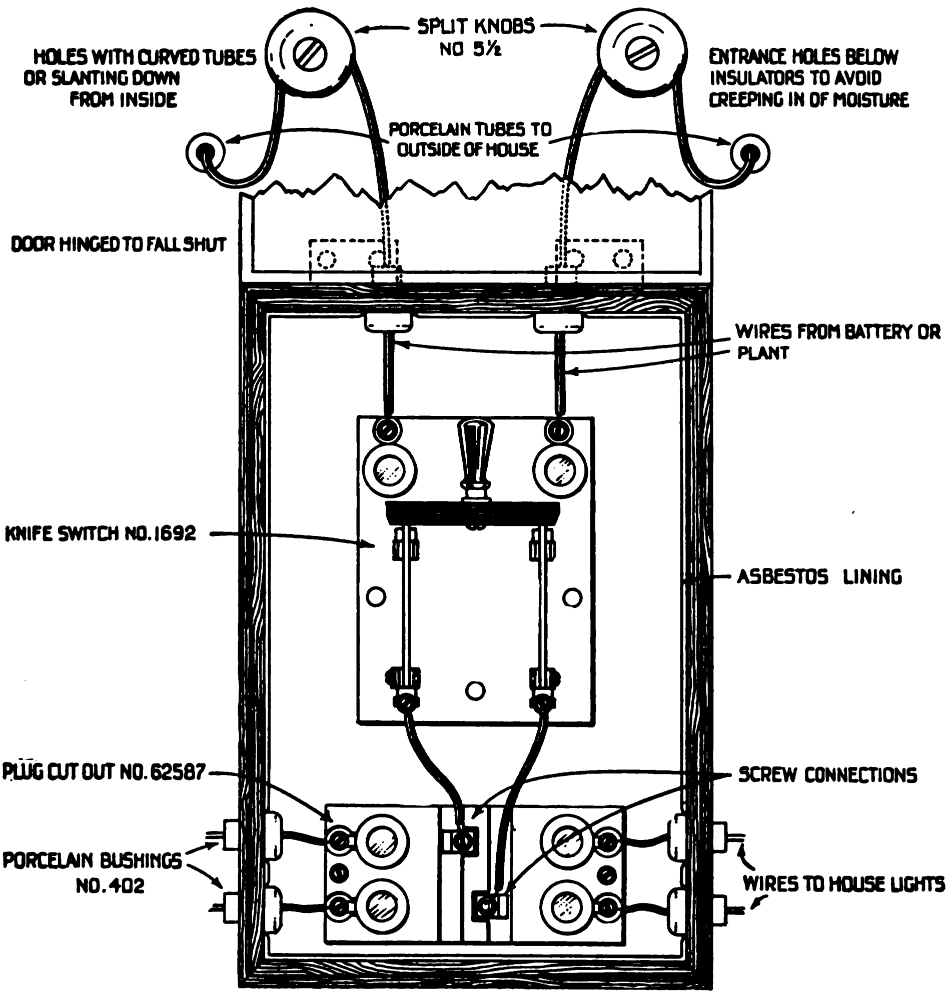
*Illustrations and text courtesy Western Electric Co. Publicity Dept.




**A typical wood cut out box such as described for the attic. Lumber ¾-inch thick. Box painted and lined with ⅛-inch asbestos. When a sheet steel box is used, porcelain bushings with clamps to hold them in the box are necessary for ordinary wires. Box connectors are used for armored cables as described.**

The armor may be cut through with a hack-saw and bent back until broken off. The wire ends are then inserted through the connector into the box, the following armored part pushed into the connector as far as it will go and the clamping ring tightened over the armor to hold it securely.

The other end of the cable is treated in the same manner, being clamped into a round steel box four inches in diameter, into which the desired connection or appliance is later to be placed. For example, if a single light only is to be set in the box, the latter is located probably in the ceiling.

In this case, a hole the size of the box is cut in the ceiling, the box screwed to a piece of board and the board fastened between the beams (see diagram), as in the case of the fixture boards previously described in the knob and tube wiring section.

The height of the board above the ceiling is regulated so that the edge of the steel box sets flush with the ceiling down below. A couple of cleats or strips of wood nailed on the floor beams above the ceiling will hold the board securely when the latter is nailed to them.

The ends of the cable wires are then bared and connected to an outlet box cover rosette and the rosette screwed to the box.

The rosette connections are thus enclosed in an iron box, only the lamp cord, which is attached to the rosette in the usual way, dropping through the insulated cover or canopy.

Whenever armored cable is to be led into a box to be spliced to have another circuit tapped to it, or to be connected to a receptacle or similar appliance, the cable must be cut and each of the cut ends fastened into separate holes by means of box connectors. This is because armored cable cannot be threaded into one side of a box and out of the other, but must end at each box and then start afresh in a new piece. Of course, at the extreme end of a circuit there is only the one end which stops in the box. In the diagram, the circuit is shown as running from an iron service box along a wooden beam, as in the attic or the roof of a barn and then under the flooring to reach lights in the ceiling below. In a case where a second circuit for a switch or lights is to be tapped off a main circuit, a handy method is to use a box, cutting the cable, stripping and bringing in the two ends, then joining or splicing them inside the box.

The tap circuit cable is then clamped in the box, stripped and tapped on to the main wires, as in the open wiring systems. Soldering and taping finish the job, a plain cover then being screwed on to the box to close it.

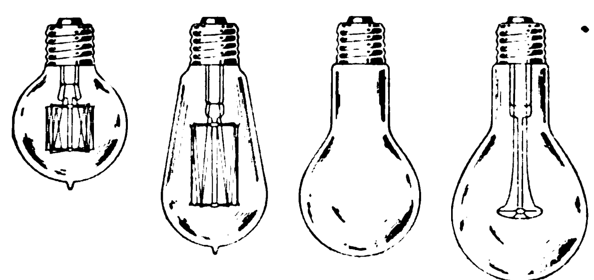
The steel covering of armored cable must be grounded. This is done by clamping on a ground clamp, and connecting the clamp by means of a No. 6 bare copper wire to a water pipe or to a ground cone, which is a perforated sheet copper cone filled with charcoal and buried in the earth.

### Tools Required for Wiring Jobs

To make a good wiring job the following tools are needed, the list given here including those needed for all three methods of wiring described, that is, the open type, pipe conduits and armored cable.

One pair electrician's side cutting pliers, 8 inches.
One 8 inch screw driver.
One 3/8-24 inch bell hanger's bit.
One ratchet brace.
One claw hammer.
One 12 inch hack saw.
One 12 inch pipe wrench.
One pipe cutter.
One strong 2-bladed knife.
One small soldering torch.
One small flat file (fine).
One pair scissors (will be found handy, but can be dispensed with).
All tools should be of the best grade.

*Home Varieties of Westinghouse Lamps*



(1) Round bulb, 15 & 25 Watts
(2) Straight-side, 10, 15, 25 & 50 Watts
(3) Pear shaped, gas-filled, "White Mazda," 50 Watts
(4) Pear shaped, gas-filled, clear glass, 75 Watts

# How to Figure Wire Sizes

### To Determine Size Wire for 110 Volt Circuits

With current at 110 volts, No. 14 (B & S gauge) copper wire is usually satisfactory for the wiring of houses and barns.

The chart shown below may be used for determining size of wire for specified loads at various distances. The drop will be limited to 5 volts.

Example: To find the proper size of wire for 600 watts at a distance of 250 feet, requiring 500 feet of single wire, follow the 600-watt line horizontally across the chart until it intersects the 500-foot vertical line. The point of intersection lies in the No. 12 zone, indicating that No. 12 wire is the size to be used.

**Note:**—Wire length to be used is twice the wiring distance between points to be wired.

### To Determine Size of Wire for 32 Volt Circuits

No. 12 (B & S gauge) copper wire is satisfactory for a large part of ordinary housewiring for 32-volt circuits. Where the load is in excess of 300 watts, in the kitchen or laundry, for instance, special circuits of larger

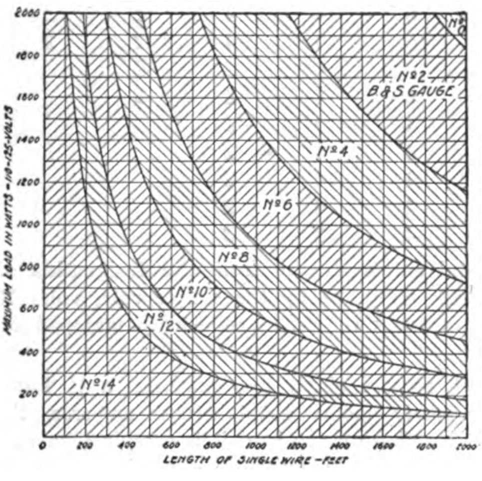



**Chart for determining size of wire 110 volt circuits**

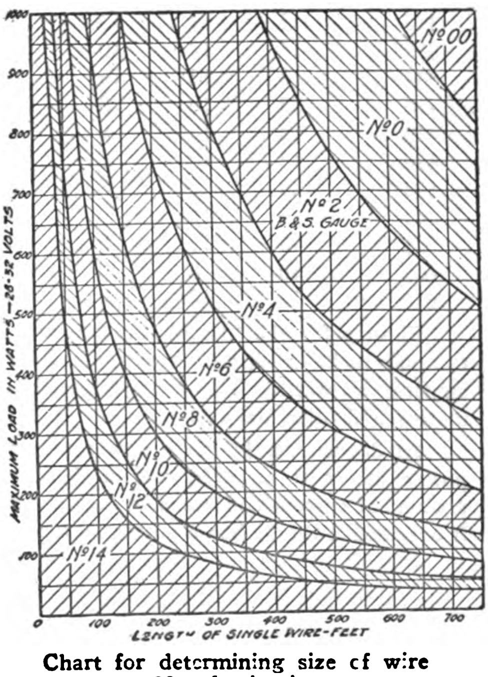



**Chart for determining size of wire 32 volt circuits**

wire should be provided, and also in cases where even small loads are great distances from the plant. Bear in mind that larger sized wire is required for a 32-volt circuit than a 110-volt circuit for carrying the same amount of light or power. This is due to the fact that the amount of current or amperage required on a 32-volt circuit is nearly four times as great as on the 110-volt circuit.

The chart shown below may be used for determining size of wire for specified loads at various distances. The drop will be limited to about 2 volts.

Example: To find the proper size of wire for 600 watts at a distance of 150 feet, requiring 300 feet of single wire, follow the 600-watt line horizontally across the chart until it intersects the 300-foot vertical line. The point of intersection lies in the No. 4 zone, indicating that No. 4 wire is the size to be used.

Limiting the voltage drop in the wiring for country home lighting plants is essential to the successful operation of lamps and appliances. Use the above chart in determining the size of copper wire for 28–32 volt installations. Wiring properly installed for 28–32 volt plants may at any later time be used for regular 110 volt service.

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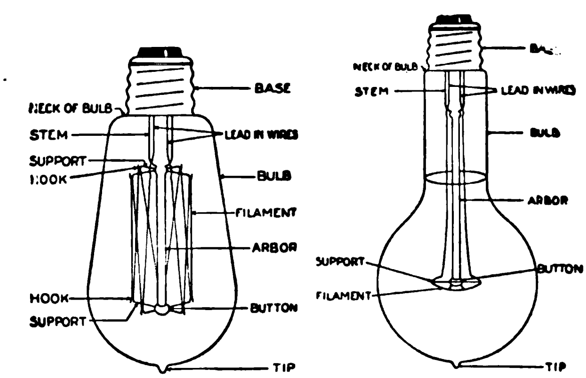
## PROPER SIZES OF WIRE FOR 32-VOLT TRANSMISSION

| Load in | Distance in feet from Plant to place used | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Watts | 25 | 50 | 75 | 100 | 150 | 200 | 300 | 400 | 500 |
| 32 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 64 | 12 | 12 | 12 | 12 | 12 | 12 | 10 | 10 | 8 |
| 96 | 12 | 12 | 12 | 12 | 12 | 12 | 10 | 8 | 6 |
| 128 | 12 | 12 | 12 | 12 | 12 | 10 | 8 | 6 | 6 |
| 160 | 12 | 12 | 12 | 12 | 10 | 8 | 8 | 6 | 4 |
| 192 | 12 | 12 | 12 | 12 | 10 | 8 | 6 | 4 | 4 |
| 224 | 12 | 12 | 12 | 10 | 8 | 8 | 6 | 4 | 4 |
| 256 | 12 | 12 | 10 | 10 | 8 | 6 | 4 | 4 | 2 |
| 288 | 12 | 12 | 10 | 10 | 8 | 6 | 4 | 4 | 2 |
| 320 | 12 | 12 | 10 | 8 | 8 | 6 | 4 | 2 | 2 |
| 352 | 12 | 12 | 10 | 8 | 6 | 6 | 4 | 2 | 2 |
| 384 | 12 | 12 | 10 | 8 | 6 | 4 | 4 | 2 | 2 |
| 416 | 12 | 10 | 8 | 8 | 6 | 4 | 4 | 2 | 2 |
| 448 | 12 | 10 | 8 | 8 | 6 | 4 | 2 | 2 | |
| 480 | 12 | 10 | 8 | 8 | 6 | 4 | 2 | 2 | |
| 512 | 10 | 10 | 8 | 6 | 4 | 4 | 2 | | |
| 544 | 10 | 10 | 8 | 6 | 4 | 4 | 2 | | |
| 576 | 10 | 10 | 8 | 6 | 4 | 4 | 2 | | |
| 608 | 10 | 8 | 8 | 6 | 4 | 4 | 2 | | |
| 640 | 10 | 8 | 8 | 6 | 4 | 2 | 2 | | |

Figures for the "Load" Column are found either directly from the designation of the unit to be used, as for example, a "40-watt lamp" or by the simple rule, volts × amperes = watts. The voltage, speed and amperes required are usually stamped on motors and other devices.

At 32 volts, a 1/8 horse power motor will require about four amperes, a 1/4 horse power motor 8 amperes, and a 1/2 horse power motor about fifteen amperes, the amount of current consumed by any motor depending on the load it is carrying, so that if overloaded the 1/2 horse power motor might be drawing twenty-five to thirty amperes.




*Straight Side Vacuum Lamp—Pear-Shaped, Gas-Filled Lamp*

**Technical names of the various parts of incandescent lamps**

*Courtesy Westinghouse Lamp Co.*

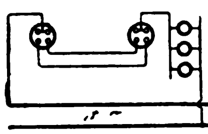
# Control of Lights from Different Points

It is not only very convenient, but sometimes necessary to be able to control a light from two or more points. For example, it is an advantage to be able to turn on the barn yard lights from the house, but it should also be possible to turn these lights on from the barn as well. This also applies to lights in cellars and out houses as well as lights on the different floors of the house itself. To accomplish this it is only necessary to use additional wire and some three or four way snap switches which cost little more than the ordinary snap switches.

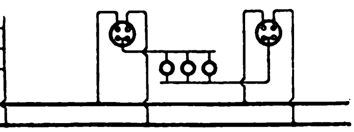
To be able to light a lamp from either of two different points by the turning of a single switch, it will be apparent that the wiring must be arranged so that the closing of a single switch closes the circuit. This is not possible with the ordinary single way snap switch since to close a circuit having two or more of these one way snap switches in it, it would be necessary to close each one of the switches.

## Types of Switches

There are three classes of switches in general use: the knife, rotary or tumbler snap and the push button switch. Both the knife and the snap switches are made in either single or double pole, but it is preferable to use only double pole knife switches. The main switch on the switchboard of the plant itself is usually a double pole knife switch. The only other place in which this type should be used is on the cut-outs of junction boxes, or panel boards, that is, where branch circuits are taken off a main circuit, as for house lighting, the terms junction box and panel board referring to the same thing. Push button switches are used chiefly for the house circuits in connection with concealed wiring and their only advantage is that of



**Right way, by connecting each switch to a different leg of the circuit**



**Wrong method of connecting 3-way switches**


**Details of terminals and straps in 3- and 4-way switches**

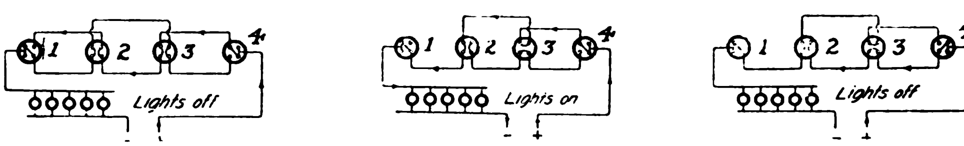
appearance. They cost about twice as much as the snap type. The snap switch may be used either with open or concealed wiring. A single pole switch is one which opens but one side of a circuit, while the double pole switch opens both sides of the circuit at the same time. For anything except branch circuits carrying a few lights, the underwriters do not favor the use of a single pole switch.

## Three and Four Way Switches

These do not differ in external appearance and size from the standard snap switch. They are used chiefly to control lights from two or more locations. The three-way switch differs from the standard type in that two of its four terminals are connected together, making three points, from which the term three way, or three point, switch comes. The underwriters classify the three way switch as a single pole switch and as such it can only be properly connected in but one side of its circuit.

Four way switches connect together the two top terminals and also the two bottom terminals of the switch with a single turn of the operating button. The four way switch is equipped with two blades while the three way switch has but one blade which is always in contact with one or the other of two of the terminals. *Illustrations Courtesy Science and Invention.*

Three way switches are commonly used for stairways or basements and for an outside light where two points of control are desired; for example, a barnyard light that can be turned on either from the house or from the barn. These three way switches cannot be used except for the end positions on the circuit. That is, where it is desired to turn on the barnyard light from the house and the barn, the two switches must be placed at the end of the circuit. The four way switch, however, can be used either for the end position or for any intermediate position in the circuit. In connecting up three way switches, care must be taken to see that wires of opposite polarity are not brought into the same switch. This is made plain by the illustrations which show the right and the wrong method of connecting up this type of switch. If wires of opposite polarity are brought into the same switch as shown by the cut of the wrong method, there is danger of a short circuit occurring in the switch itself.




**Use of 3- and 4-way switches in combination to permit of turning lights on and off from any one of four different points**

Where it is only desired to control a light from two points, the three way switch answers all the requirements, but where it is convenient or necessary to control the same light from more than two points, four way switches are used at intermediate points on the circuit. The illustration shows the wiring necessary for a circuit by means of which the same light can be controlled from any one of four different points, three way switches being used at the end of the circuit and the four way type for the two intermediate points.

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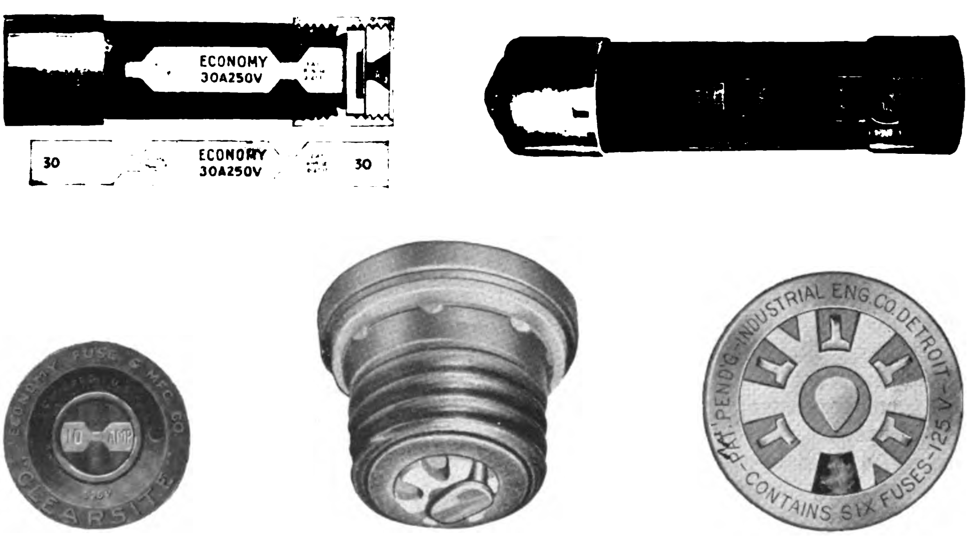



**Some representative types of renewable cartridge fuses, renewable plug fuse, and multiple plug fuses. See following pages for text**

# Protection of Circuits

EVERY circuit of a farm light and power plant installation must be protected by fuses to prevent damage to the apparatus and guard against fire, in case of overloading, short circuiting or grounding. The meaning of these three terms is explained in detail in another chapter, "Locating Short Circuits and Grounds."

On a 32-volt system, the smallest wire recommended for the branch circuits is No. 12. The carrying capacity allowed by the Underwriters for this size wire is 20 amperes. It is accordingly permissible to use 25 ampere fuses in each branch circuit of a 32-volt system, but the circuits themselves should be laid out so that the maximum ordinary load to be carried by each of these branch circuits does not exceed 20 amperes. This makes the carrying capacity of the circuit 20 $\times$ 32 or 640 watts, this carrying capacity being based upon the use of rubber covered wire. For weather proof insulation, the Underwriters allow a slightly higher carrying capacity, or 25 amperes for No. 12 wire.

For the kitchen circuit in the dwelling it would be preferable to use No. 10 wire which has a carrying capacity of 25 amperes for rubber covered and 30 for weather proof, since this circuit must carry the washing machine, churn, fan and sometimes an electric iron, in addition to lights, although it is not good practice to use an electric iron at the same time that the lights are on, since the iron alone represents practically the entire capacity of the circuit. Even though a No. 10 wire is used for this circuit, 25 ampere fuses would still be the right size since they are designed to carry a slight overload and would not be apt to blow with the average load placed upon this circuit.

The remaining circuits in the house which are usually designed to carry lights alone can be of No. 14 wire, which has a carrying capacity of 15 amperes with rubber covered installation. These circuits should be protected by 15 ampere fuses and the number of lights placed on each circuit should not exceed 15 $\times$ 32 or 480 watts.

Since the main fuses must represent the entire capacity of all the branch circuits in the house, the size required for this will depend upon the number of branch circuits. An ordinary dwelling of eight to ten rooms will not require more than three branch circuits, two of which may be protected by 15 ampere fuses and one by 25 ampere fuses, so that 50 ampere fuses on the main will supply ample protection. In many installations, entire reliance is placed upon the fuses at the switchboard on the plant itself, but this is not good practice and will prove highly inconvenient in case of a short circuit or ground occurring after nightfall.

Where the house has at least three branch circuits, each of which is protected by fuses, and corresponding branch circuits for the barns and other out houses similarly protected, a short circuit or ground on any one of these branches will only put that particular branch out of service and will also make it easy to locate the fault. The size of the fuses to be used on branch circuits in the barn will depend entirely upon the amount of power that will be drawn from the circuit and should be figured by adding together the consumption of all the motors and lights carried by any one circuit. Reference tables in another part of the book give the number of watts required by small motors while the size of the lamps used indicates their current consumption. Other tables give the carrying capacity of different sizes of wire. While it will probably be rare for all of the appliances and lights on any one circuit to be in use at the same time, the size of the wire and the fuses required is based upon the maximum carrying capacity of the lines.

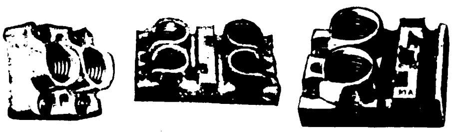
### Types of Fuses

Two types of fuses are used and these may be had in all the sizes necessary to cover the requirements of farm light and power plants. These are the plug fuses and the cartridge type fuse, the former being most generally employed on all branch circuits while the cartridge type fuse is usually employed on the switchboard of the plant and may also be used for the main line fuses of the junction box located in the house and from which the branch circuits are taken. If there is a group of out buildings at some distance from the plant, it is good practice to run a main line circuit of the largest size wire needed to carry the entire load of these buildings and to locate another junction box in a central position from which branch circuits may be taken to different parts of a large barn or to nearby buildings.

Fuses of either type are located in cut outs. These are porcelain blocks carrying sockets into which the plug type of fuses are directly screwed in the same manner as a lamp, while for the cartridge type fuse an insulating support of slate or similar material is provided, carrying clips similar to those of a switch. The carrying fuses have terminals which are pushed into these clips. The plug type fuses are more generally used owing to their lower first cost, but both the plug and the cartridge type fuses may be had in renewable form. In the plug fuse, this consists of fuse wire or strip which may be had in the different sizes. When a fuse blows, a piece of this wire or strip of the proper length is cut and fastened under the screw terminals of the fuse. For the cartridge type fuses, new links of the proper size may be had from the manufacturers.

In old wiring, open fuse blocks will often be noted. These are simply porcelain supports on which the fuse wire is attached and held by means of screws, there being no protection. This open type is no longer permitted by the Underwriters, as when the fuse blows an arc is formed and the molten metal is thrown quite a distance, so that there is danger of fire. All fuses work on this principle, the fuse wire being made of the proper size to carry the load for which it is to be used. Any great increase in this load causes the wire to melt and breaks the circuit, thus protecting the battery, generator or other apparatus on the line.

The accompanying illustrations show the two types of fuses and the various forms of cut-outs which may be had. Where it is desired to cut



**Various types of fuse blocks used for protecting circuits**

the power off any branch circuit more or less frequently, the fuse block carries a switch in addition to the fuse sockets. In the case of circuits that are seldom opened, as in the branch circuits of the house, no switch is nec-

essary. Any number of these fuse blocks of the single or double circuit type may be used together to form any combination desired. To mount them, a piece of board of the necessary size should be covered with sheet asbestos and the fuse blocks screwed to it. For example, to make a junction box for the house, place one single circuit fuse box at the head of the board in an upright position.

Then place one or more double circuit fuse blocks directly below it in a horizontal position. The mains from the plant or battery are led to the upper terminals on the single fuse blocks and the wires from the lower terminals carried down through the center of the two double fuse blocks.

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# Locating Short Circuits and Grounds

ONE of the forms of service that the dealer will be called upon to render to his customers is what is known by experienced wiring men as "trouble shooting." The customer will complain that he cannot obtain any light or current on a certain circuit and that every time he puts a new fuse in that circuit it immediately blows out. It's up to the dealer to find out why and to put the circuit in working condition. A few of the commoner causes that usually lead to this trouble are given here together with the easiest means of locating the fault and remedying it.

When a fuse blows out, it indicates one of three things. First, the circuit may be overloaded. That is, more lamps or appliances may have been turned on in that circuit than it is designed for so that it is drawing a greater amount of current than the circuit is designed to carry safely and the fuse accordingly melts, or blows out to protect the circuit. Second, there may be a short circuit on that particular line. Third, there may be a ground on the line.

If the fuse has blown out because of an overload, turning off some of the lights or taking some of the appliances out of the circuit will show this by the fact that when new fuses are inserted in the cut-out, they place the circuit in operating condition again without any further trouble. If, however, the trouble is either a short circuit or a ground, putting a new fuse in the cut-out will immediately result in blowing that fuse as well, showing that the circuit is not open. While the result of a short circuit or a ground is the same, the two are not produced by the same cause. A short circuit results where the two wires of the same circuit come together at a point at which they carry no insulation. A ground results when the positive side of the circuit comes in contact with the earth, or what is its equivalent, a pipe or other metal that runs into the earth.

### Common Causes of Shorts and Grounds

Most shorts come from carelessness in connecting up lamp sockets, connecting plugs, electric irons and the like, or result from wear on these connections. The flexible cord used for these purposes consists of a large number of very fine wires stranded together and unless all of the strands are firmly fastened under the connecting screws, any movement of the connection or appliance tends to cause one or more of these strands to stick up and bend over so that sooner or later it comes in contact with the opposite connection and a short circuit results. This is particularly the case with electric irons, since the wire leads close to the iron get quite hot, while the constant movement back and forth of the iron bends the lead frequently and results in the breaking of some of the fine wires.

The latter may then work up through the insulation or they may cause small arcs which burn off part of the insulation and the bare wires then come into contact at some point. An electric iron will show symptoms of developing a short by failing to heat properly several times before the fuse

actually blows out. It is an easy matter to cut off a few inches of the cord and make new connections. The use of an iron provided with a connecting plug having a swivel and steel spring wire coils over the flexible leads to prevent damage from bending will avoid trouble from this cause for a long period.

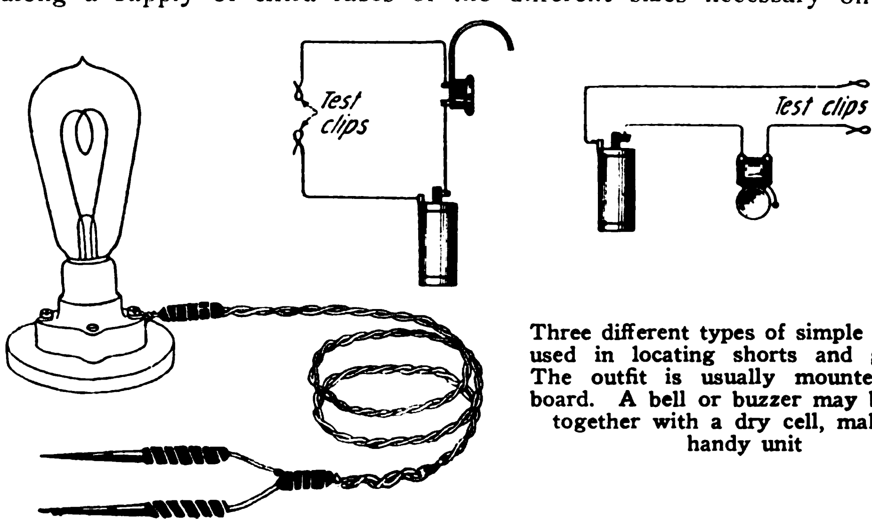
Similar short circuits also occur in the screw plug end of flexible cords used for washing machines, churns, vacuum sweepers, sewing machines and the like, since the cord is usually used to pull the plug out of the socket. This may be prevented to a great extent by tying a large, hard knot in the flexible cord just inside of the plug so that all of the strain comes on this knot and does not reach the actual connections themselves, but it is a good thing as well to tell your customers to pull the plugs out by grasping hold of the plug itself and not by yanking on the cord. Pulling them out by the cord is bound in time to loosen the flexible wires from under the binding screws, permitting them to come in contact with each other and blowing the fuse on that line.

Shorts also commonly occur because the flexible cord is allowed to get wet, particularly when used as connection to the washing machine or for other appliances in the kitchen. When called upon to remedy trouble of this kind, always look first at the plug connections of the various appliances and note whether any of the flexible cord has been allowed to lie on the kitchen floor in damp places.

Cheap fittings also constitute another frequent cause of shorts. This is particularly the case with pull sockets. The chain breaks within half an inch or so of the socket and the short end flips into the opening, causing a short circuit. Before starting to hunt the trouble, always ask those in the house what happened when the current went off. Usually the answer will be, "When I turned on the lamp (washing machine or whatever the appliance may be) there was a flash and then it wouldn't run." This will show you where to look first and save a lot of time examining things that are not at fault.

### A Simple Test Set Necessary

When no one gives you an indication of what caused the trouble, you will have to hunt this up and to do this easily it will be necessary to provide some simple form of test set that will enable you to determine offhand whether a circuit is open, or short circuited. There's no use of trying the board with a new fuse because in nine cases out of ten the new fuse will blow out and you won't be any nearer to the solution of the problem. Take along a supply of extra fuses of the different sizes necessary on all of




**Three different types of simple test sets used in locating shorts and grounds. The outfit is usually mounted on a board. A bell or buzzer may be taped together with a dry cell, making a handy unit**

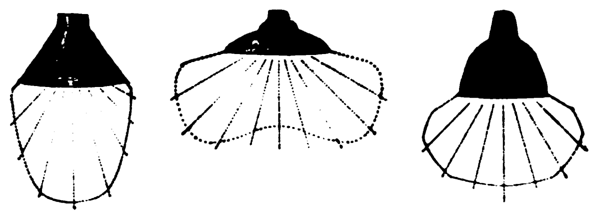
your trips, whether they are specially service calls or not, but also take along your testing set and use it before you waste any new fuses.

You can rig up a test set at an expense of a dollar or two in less than an hour. The illustrations show three different types of test sets, all of which are equally simple. The first two are designed to test circuits with the aid of an outside source of power. This is the dry battery shown. The one on the left consists of a dry cell, a little wire with test clips or points on the end and a single telephone headpiece. When the test clips or points are put on the two sides of the circuit and the latter is shorted, there will be a click in the telephone receiver, every time the test clips are touched. The second set consists of a dry cell and a bell both of these fastened down on a small piece of board, making it convenient to use both hands on the wires with the clips. When using a set of this kind always be sure that nothing is pressing up against the bell to prevent it from ringing, likewise that the dry battery hasn't gone dead since it was used last, As a preliminary to using this set, the test clips ought to be set together to make the bell ring before starting to examine the circuits at fault.

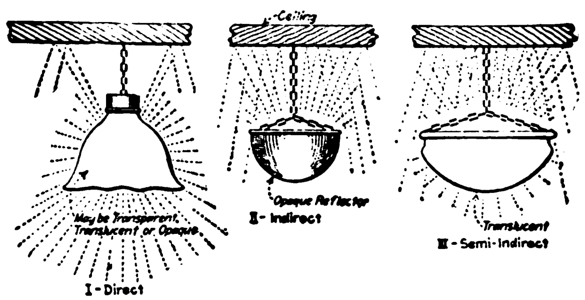
The third set is also practical for this kind of trouble hunting. It consists of an electric light socket screwed on to a board and connected to a piece of flexible cord, the ends of which are bared and soldered to two pieces of brass or iron ground down to a point, as shown by the illustration. Putting plenty of tape around the ends of these as shown will make them convenient to handle. Use a carbon filament lamp for this purpose as it will stand a great deal more rough handling than any other type. When the points are applied to opposite sides of any live circuit, the lamp will light.

In order to determine whether a circuit on which a fuse has blown has become short circuited, replace the fuse with a lamp. If the lamp lights up it will indicate that there is either a short or a ground on that particular circuit. If it does not light, a new fuse may be used to replace the lamp, as this would indicate that the fuse had been blown by an overload and not by a short circuit or a ground. Assuming that the lamp does light, indicating trouble somewhere on that circuit, leave the lamp in place while examining all of the plugs, sockets and similar connections on that circuit. They will readily show by sparking or even slight burning of the insulation if the trouble has been caused by some of the strands of flexible cord having gotten out of place.

**Every light should be shaded in some way. Besides being highly injurious to the eyes, the glare of an unshaded high power bulb casts strong and deceptive shadows, and a large part of the light itself is wasted instead of being directed where needed**



*Three Kinds of Direct Reflectors*




*Direct, Indirect and Semi-Indirect Reflectors*

*Illustrations Courtesy Westinghouse Lamp Co.*

# THE RIGHT LAMP IN THE RIGHT PLACE

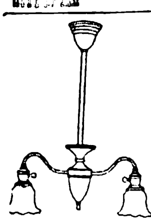
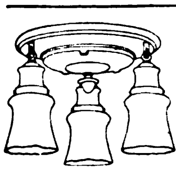
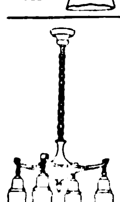
The comfort and appearance of every home depend upon the manner in which each room is lighted. The wrong or right lamp in any fixture means the difference between good and poor lighting. Good lighting depends upon the combination of proper lighting and fixtures.

This chart will enable the dealer to select the proper lamp for any lighting fixture in any size room. The fixtures shown in this chart are typical of those found in the average home. A customer needs only to refer to the fixture similar to his and state the approximate size of the room to enable the dealer to give him the proper lamp for his particular needs.

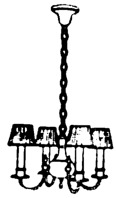
It is a poor policy to put a large lamp in a fixture where two or three smaller lamps should be used. When all sockets contain lamps and are lighted at the same time the desired effect is obtained. However, if but one lamp is lit—no matter whether it is a smaller or larger lamp than necessary—an over-balanced effect is the result. Since fixtures are merely decorative means for distributing light, the light sources should be well balanced and so arranged to present the same harmonious appearance when lighted as they do when not in use.

The same lamps should not be used in a small room as in a medium or large sized room when it is desired to obtain the best lighting effect. A large lamp in a small room is just as bad as a small lamp in a large room. The tendency of the average user is to employ bulbs of various sizes indiscriminately, or all of one size, usually larger, for all purposes. Apart from the unsatisfactory lighting conditions resulting, it is very poor practice since it wastes gasoline and oil. Both are used up in producing current, whether it is employed to charge a storage battery or used direct from the generator, so that burning a 50-watt lamp where a 15-watt would serve the purpose better, not only wastes fuel, but storage battery life as well.

Follow this chart and sell real lighting satisfaction:

| GENERAL TYPE OF LIGHTING FIXTURE | Recommended sizes of Lamps for | | |
|---|---|---|---|
| | SMALL ROOM (9′ x 12′ or less) | MEDIUM ROOM (Approx. 12′ x 15′) | LARGE ROOM (15′ x 20′ or more) |
|  Single Outlet Ceiling Unit | 50-watt White Mazda Lamps | 75-watt Bowl Frosted Mazda C Lamp | 100-watt Bowl Frosted Mazda C Lamp |
| | Next size smaller lamp may be used when side wall brackets or other lights are used. | | |
|  Double Outlet Ceiling Unit | 40-watt Bowl Frosted Mazda B Lamps | 50-watt White Mazda Lamps | 60-watt Bowl Frosted Mazda B Lamps |
| | Next size smaller lamp may be used when side wall brackets or other lights are used. | | |
|  Three Outlet Ceiling Unit | 25-watt Bowl Frosted Mazda B Lamps | 40-watt Bowl Frosted Mazda B Lamps | 50-watt White Mazda Lamps |
| | Next size smaller lamp may be used when side wall brackets or other lights are used. | | |
|  Four Outlet Ceiling Unit | 15-watt Bowl Frosted Mazda B Lamps | 25-watt Bowl Frosted Mazda B Lamps | 40-watt Bowl Frosted Mazda B Lamps |
| | Next size smaller lamp may be used when side wall brackets or other lights are used. | | |

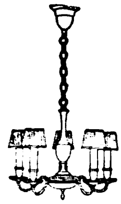
*Illustrations and Text Courtesy Edison Lamp Works of General Electric Co.*



Four Light Candlestick Unit

| | | |
|---|---|---|
| 25-watt Round Bulb—All Frosted Mazda B Lamps | 25-watt Round Bulb—All Frosted Mazda B Lamps | 25-watt Round Bulb—All Frosted Mazda B Lamps |

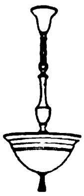
When supplemented with wall brackets use 15-watt round bulb all frosted Mazda B Lamps.



Five Light Candlestick Unit

| | | |
|---|---|---|
| 15-Watt Round Bulb—All Frosted Mazda B Lamps | 25-watt Round Bulb—All Frosted Mazda B Lamps | 25-Watt Round Bulb—All Frosted Mazda B Lamps |

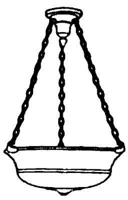
When supplemented with wall brackets use 15-watt round bulb all frosted Mazda B Lamps.



Single Outlet Indirect Unit

| | | |
|---|---|---|
| 75-watt Clear Mazda C Lamp | 100-Watt Clear Mazda C Lamp | 150-Watt Clear Mazda C Lamp |

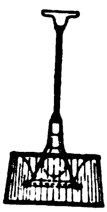
When supplemented with wall brackets the next smaller size of lamp may be used.



Double Outlet Indirect Unit

| | | |
|---|---|---|
| 40-watt Clear Mazda B Lamps | 50-watt Clear Mazda B Lamps | 75-watt Clear Mazda C Lamps |

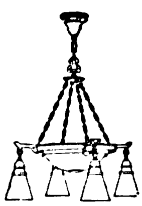
When supplemented with wall brackets the next small size of lamp may be used.



Duplexa-lite Fixture

| | | |
|---|---|---|
| 75-watt Clear Mazda C Lamp | 100-Watt Clear Mazda C Lamp | 150-watt Clear Mazda C Lamp |

When side wall brackets, 75-watt or 100-watt may be used.

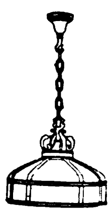


Indirect & Four Outlet Pendant Type Unit

For pendant type outlets.

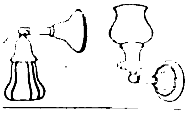
| | | |
|---|---|---|
| 15-watt Bowl Frosted Mazda B Lamps | 25-watt Bowl Frosted Mazda B Lamps | 40-watt Bowl Frosted Mazda B Lamps |

For indirect outlets same size of lamp should be used as in other indirect units.



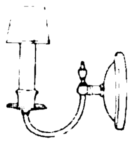
Dome Fixture

Single outlet, 50-watt White Mazda Lamp.
Double outlet, 40-watt White Mazda Lamps.
Three outlet, 25-watt Frosted Mazda B Lamps.
Four outlet, 15-watt Frosted Mazda B Lamps.



Side Wall

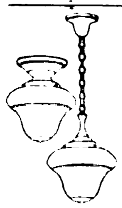
When no ceiling fixture is used 50-watt White Mazda Lamp.
When ceiling fixture used 25-watt White Mazda B Lamp.
For passageways, halls or decorative lighting 10 or 15-watt.



Side Wall Candlestick Bracket

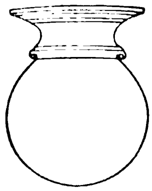
Single outlet, 25-watt Round Bulb, All Frosted Mazda B Lamp.

Double outlet, 15-watt Round Bulb, All Frosted Mazda B Lamps.



Enclosing Unit

For halls and passageways, 15 or 25-watt Mazda B Lamp.



Porch Fixtures

If used as marker or entrance light, 10 or 15-watt Mazda B Lamp.

If used for general porch lighting, 50-watt Mazda B Lamp.

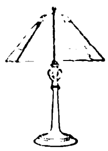
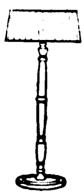


Table Lamp

Single outlet, 50-watt White Mazda Lamp.
Double outlet, 40-watt All Frosted Mazda Lamps.
Three outlet, 25-watt All Frosted Mazda Lamps.



Floor Lamp

Double outlet, 50-watt White Mazda Lamps.
Three outlet, 40-watt All Frosted Mazda Lamps.
Four outlet, 25-watt All Frosted Mazda B Lamps.

For barn lighting the proper lamp to be used will depend upon the height of the fixture or pendant above the floor and the type of reflector. For a high pendant with flat reflector, where it is desired to illuminate a large area, use the 100 or 150-watt bowl frosted type C Lamp. For a smaller area with conical reflector either a 25 or 40-watt clear lamp.

For outdoor lighting, place the bracket 8 to 10 feet high and use a 100 or 150-watt type C Lamp, either clear or bowl-frosted.

# Electric Water Systems

NEXT to the sale of the plant itself, there are two items which will be permanent standbys as boosters of the dealer's sales and profits. These are washing machines and water systems—it's hard to say which is the more important of the two, because in practically every case the dealer will succeed in selling both. It is only a question of which one he will sell first. An electric washing machine to which water must be carried and carted away is about as far from being a modern installation as can well be imagined. The electric washing machine and the electric water system go together.

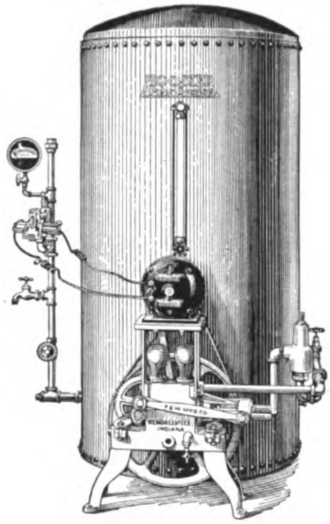
The arguments that can be advanced for the purchase of an electric water system where a plant has been installed or electric service is available, are so numerous and so obvious to anyone in this field that it is hardly necessary to repeat them at any length. The first on which the prospect should be sold is the fact that running water can no longer be regarded as a luxury but is an absolute necessity to the comfort and health of the family while it is also a great labor saving item in taking care of the stock. Barns can be kept warmer if the stock does not have to be led out to drink in cold weather or water carried in on the installment plan, while it has been proven that cows will produce considerably more if a supply of water is always within reach so that they can drink several times a day instead of twice as under the old system.

In the house itself, the water system is the greatest labor saver that has ever been offered to the farm family. Of all the forms of drudgery that the farmer's wife must perform, that of carrying water is by far the worst. And next to having to carry it in from a distance is the noisy old hand pump installed in the kitchen. Running water saves more time, labor and discomforts than any other one addition to the equipment that can be made on the farm.

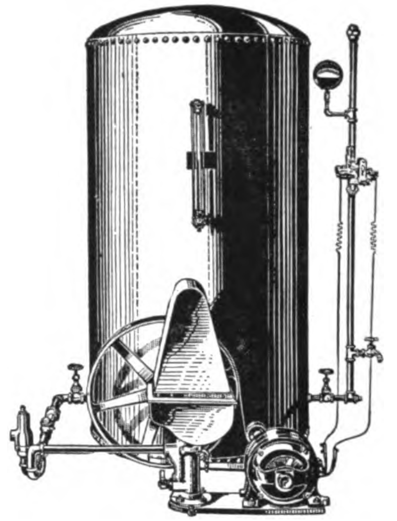
### Selling the Water System

The foregoing and a great many other equally strong arguments are just as familiar to the farmer and his wife as they are to the dealer. Both will admit them all, but—"We can't afford it." The dealer will probably run up against that reason for not wishing to put in running water more times than any other arguments in the whole catalogue. As in the case of selling the plant itself, it is largely a question of financing the sale. While a water system is not as easy a matter to demonstrate as the farm light and power plant, it can be done without any greater trouble than is required in giving a week or a fortnight trial to demonstrate a plant. One of the self-contained types in which the pump, motor and control device are all mounted on the tank, is very readily put into the cellar, or simply on the ground outside during the warmer months, and temporary piping put into the kitchen and barn. But a demonstration isn't half as important in making a sale as is the matter of putting the payments on an easy basis so that the prospect can finance the purchase in such a manner that the installments are not felt and the system really pays for itself as it goes along.

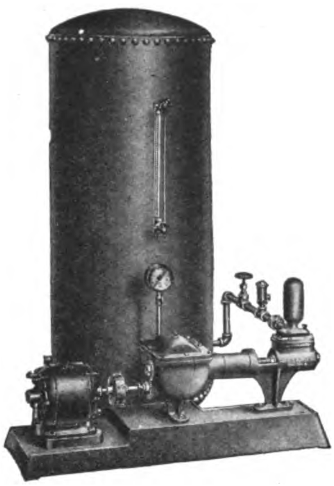
Just a word of caution in this connection. Don't overload your prospect merely because he is going to pay on the installment plan. It becomes burdensome to pay several installments a month and is apt to lead to dissatisfaction on the part of the customer with his investment. A good water system calls for an outlay almost as great as that of the plant itself, so that it would be a good thing to have the plant paid for or nearly paid for, before selling the same customer a complete water system, although in every case the dealer must be the final judge on this since he is right on the ground, knows the prospect's circumstances and can tell whether or not he is a good credit risk.



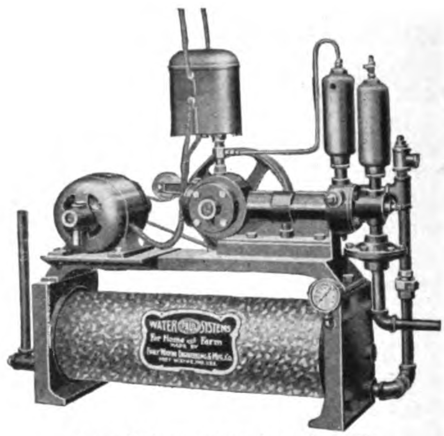
Flint & Walling



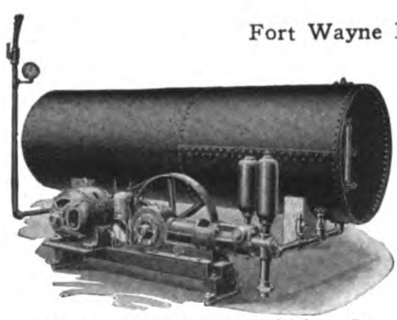
"Hoosier" Flint & Walling



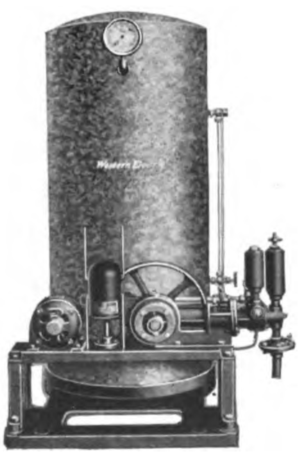
Geo. J. Roberts Co., Inc.



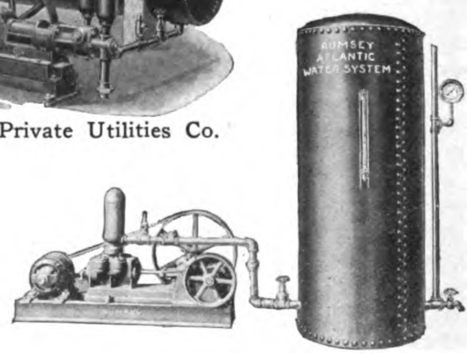
Fort Wayne Engineering Co.



Kewanee Private Utilities Co.



Western Electric




Rumsey Pump & Machine Works

There's a good water system to meet every conceivable need

## Types of Water Systems

It will not be as easy for the dealer to decide in each case just what type of system he will sell his prospect, as it will be to decide whether he should sell him or not just at that time. There are now a number of manufacturers in this field so that the market affords a special type of water system for every requirement that the dealer will need. To succeed in this field, exactly the same rules must be applied as govern the sale of farm light and power plants. Don't put in a system merely to make a sale, which means never under any circumstances sell a water system that you know will not meet the requirements satisfactorily and that can only result in making a dissatisfied customer.

Make a study of the customer's requirements and only recommend a plant that you know will give satisfactory service. If you have followed these rules in the sale of your farm light and power plant to the same customer, he will have sufficient confidence in your judgment to take your recommendation at its face value. He will buy only the plant that you recommend even if he has to wait some time to finance it and he is not at all apt to buy from some other dealer who is willing to hand him anything in the way of a water system so long as he can make a sale.

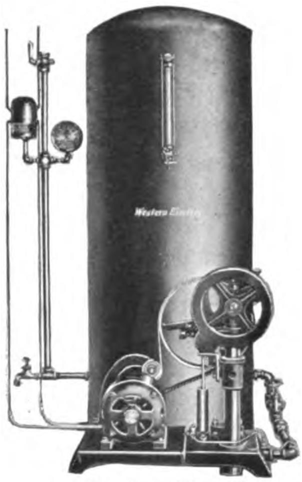
One of the most important things to do is to make a careful study of the prospect's requirements and apply the results of this study to the selection of one of the systems described here. You will run across lots of prospects who are keen to have running water but who want to buy it at a price at which it cannot be had satisfactorily in view of their requirements. Apply the rule already given for plants—don't sell what you know will prove to be unsatisfactory just to make a sale. It will not result in a profit to you in the end. In fact, it is apt to be quite the reverse.

## Centrifugal, Rotary and Gear Pumps

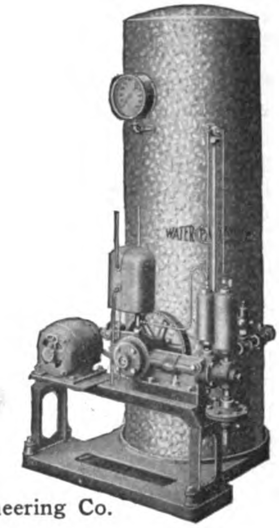
These are extremely simple and reliable types of pumps that will be found very valuable in connection with shallow well installations, or where the well is open so that the pump can be placed close to the surface of the supply, in deep wells of moderate depths. They have the advantages of doing away with packing, operate at much higher speed so that not so great a speed reduction is necessary for driving them and they require little or no attention over long periods of service. As their motion is entirely rotary, they are driven at very much higher speed and accordingly deliver a larger quantity of water in proportion to their size. Neither the centrifugal nor the gear pump is, of course, an air pump, but is designed simply for elevating water, whereas the rotary type illustrated also lends itself to the electric air pressure system which is now coming into such general use.

## Electric Air Pressure Systems

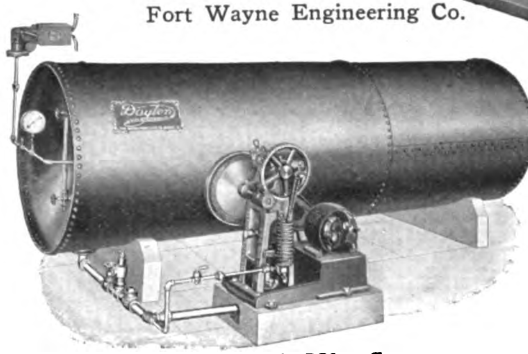
Practically all of the modern water supply systems now on the market operate on the principle of applying air pressure, either to lift the water directly from the well, whether deep or shallow, as in what is termed an airlift system, or to place the water under pressure in a tank from which it is delivered directly to the faucet. Where considerable money has already been spent on an elevated tank, or an attic tank, an automatic electric pump can be installed and the gravity supply used as previously. In certain parts of the country, where the water is very hard, these automatic electric pumps are used for supplying rain water, stored in cisterns or tanks, to the kitchen for washing purposes. Apart from cases of this kind, the modern air pressure systems are ideal and will meet practically every requirement. They avoid the first cost of an elevated tank which is expensive to build and gives trouble through freezing in cold weather, and also the attic tank puts a tremendous strain on the building plus the danger of damage from leakage. Both become overheated in summer and, although covered, the water gathers



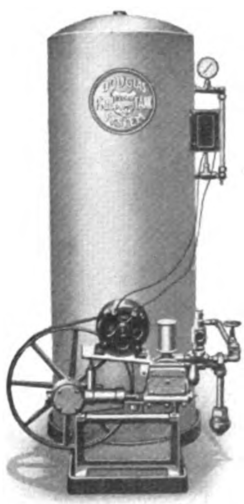
Western Electric



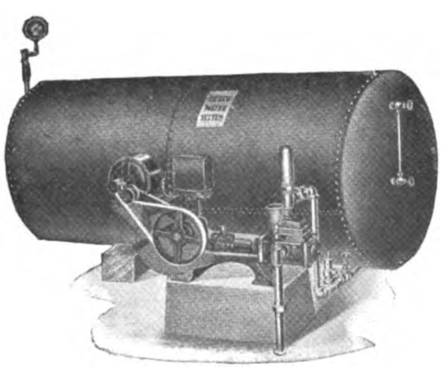
Fort Wayne Engineering Co.



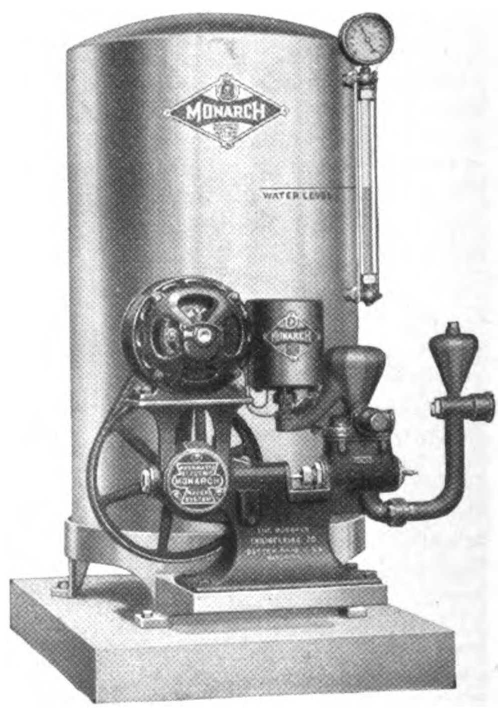
Dayton Pump & Mfg. Co.



W. B. Douglas



Rider Ericsson Co,




Monarch Engineering Co.

dirt which makes it foul. Air pressure water systems do away with these disadvantages because the water is pumped directly from the well or spring into the air-tight tank so that it provides fresh, clean water at a uniform temperature the year round. Not the least of the advantages a good water system affords is its value as fire protection, because there is always a supply of water under pressure. This is mentioned at greater length in an article under that head and it is an important factor to be considered when specifying the size of tank that should be used.

### Average Water Requirements

These should first be figured and a sufficient allowance made by specifying a larger pump and tank in order to provide a factor of safety, since a system that is too small to supply water whenever a tap is opened is not going to prove very satisfactory. The average allowance for each person in a family is 25 to 30 gallons so that for the usual family of five or six people, about 150 gallons a day will be used by the members of the family. In addition to this, there must be an allowance for washing dishes, washing clothes milk pails or a milking machine and the like. Then there is the stock tc be considered. Horses require from five to eight gallons per head, cattle seven to twelve gallons, hogs two to two and a half gallons, sheep one to two gallons per day. A three-quarter inch hose nozzle passes five to six gallons per minute when throwing an open stream.

Given any particular set of requirements, the size of pump and tank to be specified will depend upon the source of supply quite as much as the number in the family and the number of head of stock and other purposes for which water is to be used. Where there is a spring or a good shallow well from which an ample supply of clean, pure water is obtainable, both a smaller pump and a smaller tank will give more satisfactory service than the same size pump and tank would on a deep well. It takes considerably more time and power to raise water from 100 feet down than it does when the source of supply is within 25 feet or less of the pump placed on the ground or in the cellar of the dwelling.

### Types of Pumps Employed

There are several distinct types of systems from which the dealer can choose the one best suited to any prospect he has in mind. The first of these is the direct pump, shallow well system in which the lift from the water supply does not exceed 25 feet vertically. A smaller pump and tank will take care of the requirements where favorable conditions of this kind are found, though it is always good practice to put in a larger system than is actually necessary to meet the requirements. Reserve capacity is quite as good a thing in a water system as it is in a heating system.

The second type is a direct pump and tank for deep well pumping. A deep well outfit is one in which the surface of the water supply is anything in excess of 25 feet below the level of the ground, or the level on which the pump itself is actually placed. A pump raises water by creating a vacuum so that the atmospheric pressure forces the water up into the pump following the suction of the piston in the cylinder. At sea level this atmospheric pressure is 14.7 lb. per square inch and is generally considered as 15 lb. for simplicity of figuring.

Theoretically, a piston pump should be able to lift water 30 feet at sea level, but for practical working it is not customary to specify anything in excess of 25 feet and it will be found more satisfactory not to have this distance exceed 20 feet. This is the distance above the water that the cylinder of the pump can be placed. The nearer the cylinder can be placed to the surface of the water, the more satisfactory will be its operation. If it can be actually submerged, so much the better as in such a case it will never need priming no matter how long it may happen to stand idle. In figuring

on a deep well installation, always provide for placing the pump within 20 feet or less of the surface of the supply and it must be borne in mind that the latter will frequently sink considerably when drawn upon steadily. That is, if a pump as originally installed is within 20 feet of the surface of the water in a deep well, two or three hours pumping may cause the surface to recede several feet so that the pump will either be working at a very low efficiency or cease to draw water altogether by reason of the supply having gone down beyond 25 feet below the cylinder. See to it that the pump cylinder is placed close to or actually in the water and specify a sufficiently large pump cylinder and supply pipe so the electric motor will not be overworked in trying to keep the tank full. This is governed chiefly by the capacity of the pump supplied with the outfit, but many prospects will want to cheapen the first cost by putting down smaller cylinders and supply lines.

### Air Lift System

Another type which the dealer will find quite an important factor in meeting many of the requirements in his territory is known as the air lift system. In the two foregoing systems, both water and air are pumped into a tank until the air pressure is raised to a point between 40 to 50 lb. on the average. When the air pressure drops to 20 lb., the automatic controller throws the switch and starts the electric motor which then runs the pump until the air pressure is again raised to 40 or 45 lb., according to the point at which the controller is adjusted to cut off. When a faucet is opened anywhere on the line this air pressure forces the water out of the tank. This applies to both shallow and deep well systems as they both operate on the same principle regardless of the source of supply.

The air-lift system on the other hand does not employ a water pump. An air compressor is used and this is run to store air pressure in a tank. This air pressure is exerted on the source of supply in the ground, whether the latter be a shallow or deep well, through a special orifice, commonly known as a footpiece. Whenever a faucet is opened at any point this allows air under pressure to escape through the footpiece and force water up through the line so that all water used is always drawn directly from the spring or well, none being carried in a storage tank at any time. An electric controller set between similar limits of pressure, maintains the air pressure in the tank by running the air compressor whenever it falls below a certain point. Air lift systems have many advantages in connection with unusually deep well installations.

While the several air lift systems on the market differ more or less, the foregoing covers their general principles. Water is not lifted by suction, but forced directly upward by pressure and this can only be done under certain conditions. In order that there may be a sufficient weight of water above the footpiece to permit of the air forcing the water up the pipe line instead of dissipating itself through the body of the water supply, there must be a certain amount of submergence. Not all deep wells, nor all shallow wells, provide satisfactory working conditions for an air lift system, so that wherever it is desired to install a system of this kind, the manufacturer should first be given ample opportunity to study the conditions and make recommendations concerning the type of outfit they would use. In many parts of the country a good water supply can only be obtained at a depth of from 200 to 300 feet. The air lift type of system is particularly advantageous in places of this kind, provided the water in the well stands high enough to give the proper amount of submergence and does not draw down too far when the air lift is in use.

Illustrations of a number of the different types of both shallow, deep well and air lift systems, made by representative manufacturers, are shown here and there is also as complete a list as possible of the various sizes of each

system. In addition, considerable data are presented regarding systems generally so that dealers should have no difficulty in selecting the type that will meet the requirements of their customers most satisfactorily, always bearing in mind that it never pays to sell a water system simply for the purpose of making a profit on the sale. Your prospect will invariably want to get you down to the minimum first cost—he wants his running water just as cheaply as possible. Don't be misled in selling him too small or too low priced a system just on this account. Sell him something that you can honestly recommend to do the work—a system that you would put in for your own service if you were not limited as to first cost and wanted something that would deliver all the water you needed where and when you wanted it.

# Technical Data on Water Systems

## Suction Lift and Discharge Head

By suction lift is meant the vertical distance in feet from level of water at source of supply to center of pump. The length of suction pipe or horizontal distance from well to pump does not enter this measurement.

When a pump begins to work it produces a suction or vacuum by reducing the pressure in the suction pipe. The atmospheric pressure on the surface of the water in the well then forces the water into the pipe to a height corresponding to the vacuum produced by the pump. At sea level the normal atmospheric pressure is 14.7 lb. per square inch or barometric pressure which is sufficient to force water to a height of 34 inches. Due to resistance in the pump itself, air in the water, friction in the pipe and other conditions a suction pump is limited to a lift of from 20 to 24 feet in order that it may have the necessary margin of safety against failure in service. Table II shows the highest lifts of pumps of various sizes.

At high altitudes where the barometric pressure is lower than at sea level the safe suction of a pump is correspondingly reduced. This and other data are shown by Table II.

The suction list is generally given in feet but sometimes in inches of mercury. The discharge pressure is mostly given in pounds per square inch, but sometimes in feet head. In order to convert one unit of measurement into another the following simple relations exist:

Table I

| | | |
|---|---|---|
| 1.00 pounds per square inch | 2.31 feet head | 2.04 inches mercury |
| 0.43 pounds per square inch | 1.00 feet head | 0.88 inches mercury |
| 0.49 pounds per square inch | 1.13 feet head | 1.00 inch mercury |

Note.—If the water recedes while pumping, as is often the case with wells, this must be taken into consideration. A doubtful well should be tested for flow to make sure that the actual lift does not in service exceed the permissible limit.

### The Suction Lift

The suction lift is the vertical distance in feet from pump to lowest level of water, regardless of total length of pipe. In addition to the suction lift the pump is required to overcome the resistance in the pipe or friction head, measured in feet. By adding the friction head to the suction lift the total suction head is obtained which must not exceed the practical limit of a suction pump as otherwise the pump will fail to draw water or break the suction, causing pounding in the pump and water hammer in the piping.

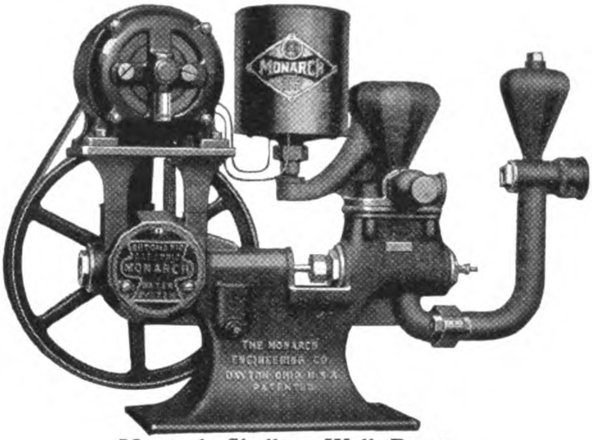
The friction head, which in long pipe lines cuts down the possible suction lift very considerably, may be greatly reduced by increasing the size of the suction pipe. Table II shows the greatest suction lift in feet on which any pump may be safely used when installed with different lengths and sizes of suction pipe. By consulting this table when planning an installation much trouble may be avoided because it clearly indicates the necessary size of suction pipe to take care of the existing suction lift in every case.

A very simple and reliable method of ascertaining the actual suction lift, including friction head, against which a pump is working, is to apply a vacuum gauge at the suction chamber after first removing the air cock. All air chambers have a ⅛-inch pipe tap at this point. The reading of the gauge is converted into feet lift as shown by Table I. The lift so ascertained indicates the true working conditions and must not exceed the permissible limit.

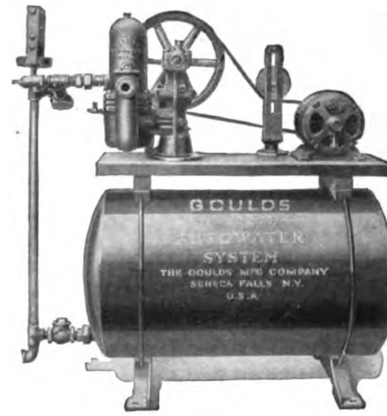
### Negative Suction Lift

As its name suggests a suction pump is intended to draw water by suction and is, therefore, properly located some distance above the level of water.

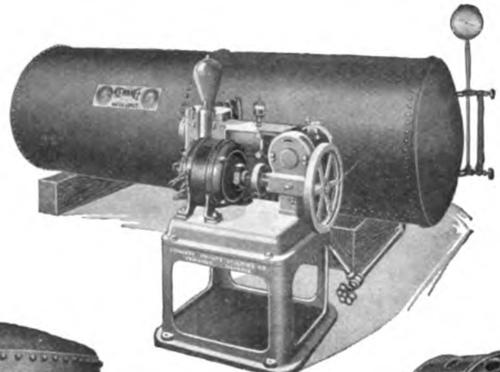
*Text and Data Contributed by C. E. Cromwell, sales manager, Fort Wayne Engineering & Manufacturing Company.*



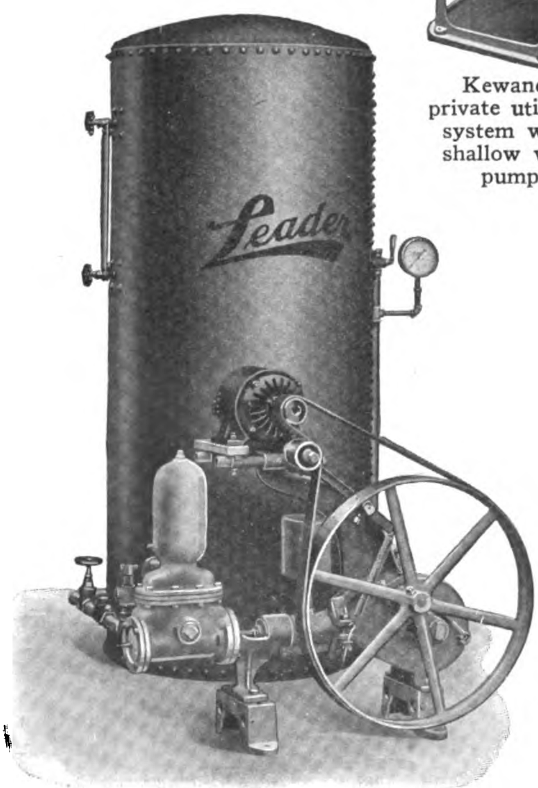

Monarch Shallow Well Pump



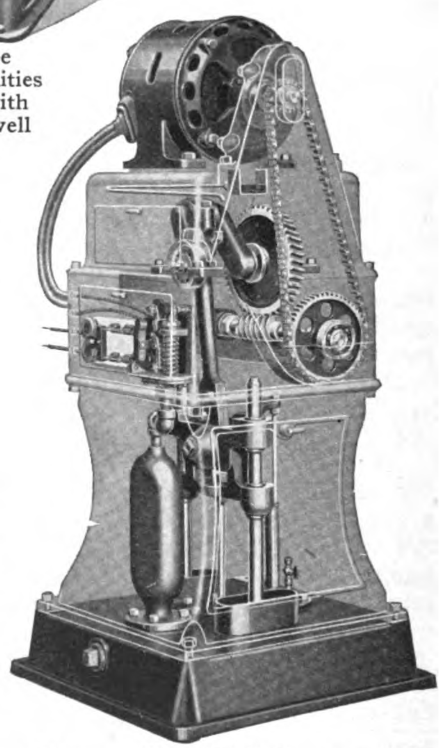

**Goulds "Autowater" System Unit**



Kewanee private utilities system with shallow well pump




**Leader Shallow Well System**



**Monarch Deep Well Pumping Unit Shown in Phantom**

Air contained in the water or entering with it will then collect in the air chambers and provide the cushion necessary to insure a steady flow of water and smooth action of the pump.

A pump located below the level of water has a negative suction lift, the water flowing to the pump by gravity no matter how the suction pipe is installed. Under such conditions there is no tendency for air to collect in the air chambers. On the contrary, the air there will gradually be absorbed by the water until the pump becomes water-logged when it will begin to work hard under normal strains on all moving parts, knock and produce water hammer in the piping. It will also often act as a booster pump at increased capacity and power consumption.

If a pump cannot be located above the water level, moderate negative suction lifts may be eliminated by placing a valve in the suction pipe and throttling the flow of water until the pump shows a good suction with the water level at the highest point and will charge air freely. The valve is then left in that position. It is also advisable to provide an extra air chamber in such cases. This can be done by means of a capped standpipe and an air cock on top of same permits the charging of air at this point. Installations of this kind require the additional attention of charging air from time to time which must not be overlooked.

### Discharge Head and Friction Head

The discharge head is the greatest height in feet to which the pump is required to discharge water added to the pressure at that point, converted into head in feet, or, the maximum water pressure at the pump expressed in feet head. When a pneumatic pressure tank is installed at the pump, the discharge head corresponds to the pressure in the tank as indicated by the pressure gauge.

The total head of water against which a pump of given capacity operates determines the work of the pump and consists of the sum of suction head, discharge head and friction head, expressed in feet or converted into pressure. The friction head which represents the amount of work caused by the friction in the pipe line resisting the flow of water is directly proportional to the length of the line and also depends upon the condition of the pipe.

On the suction side the friction head added to the vertical distance from pump to water constitutes the total lift which must be within the permissible limit. The greatest vertical suction lift in feet through various sizes and lengths of suction pipe in fair interior condition is given in Table II and clearly shows to what extent the friction cuts down the permissible lift and the necessity for providing suction pipes of proper size to meet high lifts through long pipe lines.

On the discharge side friction adds to the work of the pump by raising the pressure necessary at the pump to force the water through the pipe line. The amount of this work is given by Table III, showing the average friction losses in pounds per square inch in various sizes and lengths of piping in fair interior condition discharging the full capacity of the pumps listed. This table also determines the pressure at the end of a pipe line discharging from a pneumatic tank, the figures showing the loss of pressure at a rate of discharge corresponding to the capacity of the pump.

### Locating the Pump

Locate the pump or system in as clean and dry a place as is available in order to avoid an accumulation of dust or dirt on the apparatus and provide some ventilation to prevent excessive dampness which may affect the electric motor. A few extra feet of piping, if necessary to accomplish this, will not affect the working of the pump. Also provide a light near the pump for the convenience of attending to it and make it accessible for inspection by leaving sufficient space all around it. Small pumps, installed with over-

head tanks, may be conveniently located on wall brackets, furnished by the manufacturers and which may be fastened to two-by-fours nailed to the wall. To make a quiet installation, a pump must never be attached to a wooden partition as this acts as a sounding board.

Ice in forming, expands considerably and will burst the strongest casting. It is, therefore, necessary always to place pumps where they are protected from freezing. This is generally possible since a suction pump will draw water from a considerable distance. A suction pump must not be placed directly over a well for several reasons, given below, but should be located some distance from the well. In order to bring the pump within reach of the water or not to exceed the permissible suction lift it may be placed in a pit, properly covered and ventilated, as local conditions may suggest.

### Piping Calls for Care and Good Work

Clean out all pipes and fittings carefully before assembling and inspect them for cracks, poor threads or other defects. Use a good pipe cement and be careful to make every joint perfectly tight. Install the pipe lines as directly as possible, avoiding unnecessary bends. Give the suction line a slight, continuous rise from well toward pump and the discharge line a slight rise from pump in order to avoid air pockets and consequent difficulty of priming, surging noises and water hammer. Be particular to make the suction line absolutely air tight. When completed, test the line under air or water pressure.

When frost-proofing a pipe line by laying it under ground, see that it is properly supported and rests without bending strain upon solid earth. It may otherwise spring a leak later when the trench has been filled. Always install the piping so that it is self-supporting. Its weight must not be carried by the pump or put a strain on the fittings at the pump. Provide at least two bends near the pump in order to facilitate the breaking of the unions always to be provided next to the pump.

### Size of Pipes

Each pump is tapped for a standard size suction and discharge pipe, according to its capacity. Smaller pipes than these should never be used. When the pipe line is long and it becomes necessary to increase its size in order to reduce friction, standard size pipe and fittings are always retained at the pump and the pipe is then increased at a convenient point.

So called street elbows should never be used in place of nipples because they have a clear area considerably less than that of a standard pipe and greatly increase the friction in the pipe line.

### The Suction Pipe

One of the most important parts of a pump installation is the suction pipe which must be made absolutely air-tight and always should be tested for leaks. Any air entering on the suction side of a pump is discharged into the tank where it accumulates until it enters the service line, when the excess air must be blown off. It is well to give a suction pipe a coat or two of heavy paint to seal any slight leaks through which air may enter.

To prevent dirt and foreign matter from entering the pump and possibly lodge under the valves and interfere with their action many pumps are provided with strainers. These contain a fine mesh brass screen supported by and clamped between cast iron flanges, the clear area of which is considerably in excess of that of the pipe. They are often placed in the suction pipe just below the suction inlet to pump, next to the union, and can therefore easily be taken apart for cleaning.

Especially on cistern service and in new installations the strainer may become clogged up to such extent that the pump can not draw its full capacity, and whenever this occurs or the pump develops a knock, the strainer should be looked into.

# Monarch Water Systems

MONARCH specializes in the manufacture of electrically operated and engine driven Water Systems for city and country homes.

Monarch water systems are very definitely the leaders in their field. They represent the very highest type of engineering and manufacturing skill and the latest developments in domestic water pumps.

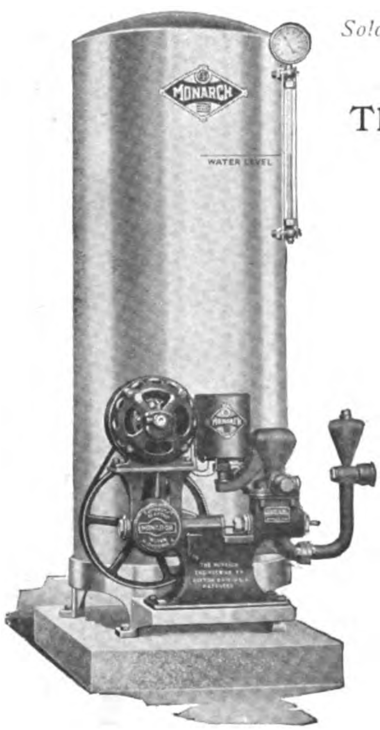
It does not require an expert mechanic to judge the advanced mechanical principles that characterize all Monarch pumps. The reasons for Monarch superiority will be quickly evident to you, if you will take the trouble to look into it.

Keep these two things in mind about Monarch Water Systems:

(1) There is a Monarch System to meet every need—for cisterns, for shallow wells, for deep wells—from 100 to 1,000 gallons per hour capacity.

(2) Monarch Systems are medium-priced; some higher, some lower, but none better at any price.

There are a number of Monarch features that you should know about—many of them patented and therefore exclusive. For instance, the Two-Pole Switch with safety throw-out device and impulse control—the improved valves—the sleeve guard, etc. Let us send you descriptive folder.




*Sold by more than a thousand jobbers and dealers throughout the United States and Canada.*

**The Monarch Engineering Co.**

**275 East First St.**

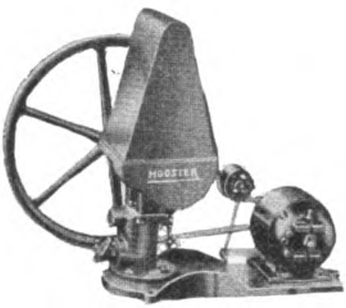
**Dayton, Ohio**

*Export Office, O. P. Brett, Mgr.,*
136 *Water St., New York*

LEFT—Monarch System No. 103 for cisterns and shallow wells. A complete unit with double acting pump and 70 gal. tank ready for installing.

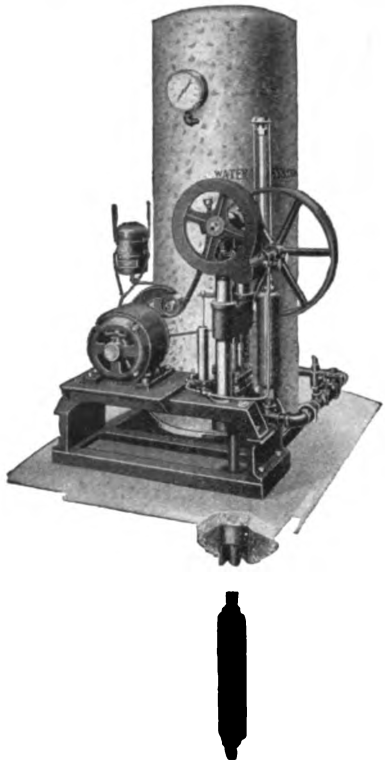
RIGHT—Monarch deep well head, entirely enclosed, silent chain and worm drive, automatic lubrication, S. K. F. ball bearings throughout, durable and efficient.

"Hoosier" shallow well pump

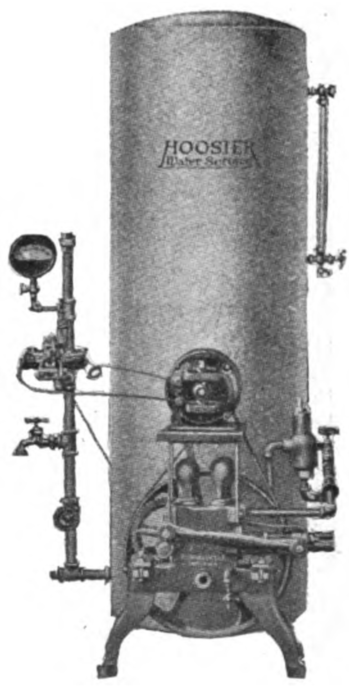



"Hoosier" pumping head

"Hoosier" pumping head with extension for frost-proofing



"Paul" deep well system




"Hoosier" shallow well outfit

The end of the suction pipe is submerged to a point below which the water level will not recede. It may be submerged a considerable distance without increasing the lift of the pump. In cisterns and shallow wells the end of the pipe must be kept well above the bottom so that dirt or sand will not be drawn into the pipe. Foot valves with strainers are generally used at the end of the suction pipe. They prevent any coarse foreign matter from entering and will keep the water up to the pump in spite of air leaks as long as they stay tight. They are especially useful on long pipe lines.

### Suction Pipes in Driven Wells

When the source of water supply is a driven well the casing must always be left open and the suction pipe from the pump run into it. If the casing is capped or made a part of the suction pipe, as is sometimes done, very abnormal conditions may result and the well is beyond control. The pump may pull a vacuum due to insufficient well capacity, causing water hammer or the suction may be killed by leaks in the casing. If the well is too small to admit the proper size suction pipe and couplings, special well couplings may be used or a size smaller pipe may be tried on low lifts, or a rubber hose may be used as a suction pipe inside the well.

Every pump should be installed with an individual suction pipe known to be air-tight and in good condition. It is not fair to a new pump to place it on a common suction line with another pump because the piping is lengthened, the number of fittings increased, air pockets may be introduced and the chances for leaks increased.

Even when installing double tank systems, one pump drawing water from two sources of supply through separate suction pipes, extreme care must be taken to keep the valves tight and valve-stems well packed. The pump will seldom work equally well on both lines, the conditions being different.

### The Discharge and Service Pipes

The discharge pipe carries the water under pressure from pump to tank or point of consumption. Every pump is tapped for a standard size discharge pipe which may be of considerable length without causing any appreciable addition to the water friction. In cases where the discharge pipe is long the friction, however, may become great enough to add considerably to the work of the pump. In order to determine this accurately a table of friction losses in pounds pressure per square inch is given, Table III*, applying to pumps discharging to full capacity through various size pipes up to one mile long. This table clearly indicates when a larger size pipe than standard should be installed in order to avoid overloading the pump and motor. The pipe and fittings at the pump of course remain standard size, corresponding to the smallest size given in the table.

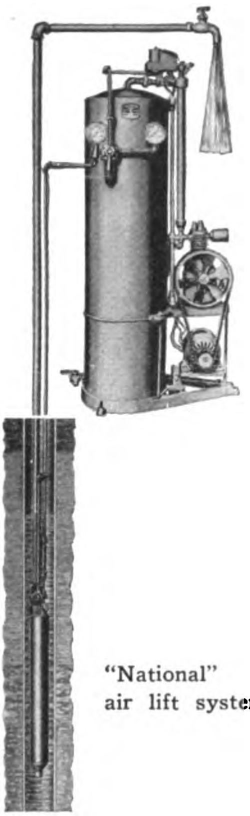
With standard pressure systems using pneumatic tanks the size of the service pipe depends only upon the fixtures to be served and is generally of the same size as the standard discharge pipe of the pump in order to take care of its full capacity.

If the pump is equipped with a "direct-from-the-well" attachment the fresh water pipe is taken directly from the pump to the cold water faucet. This pipe should be of the same size as the pump discharge and as short as possible so as to contain the least amount of storage water.

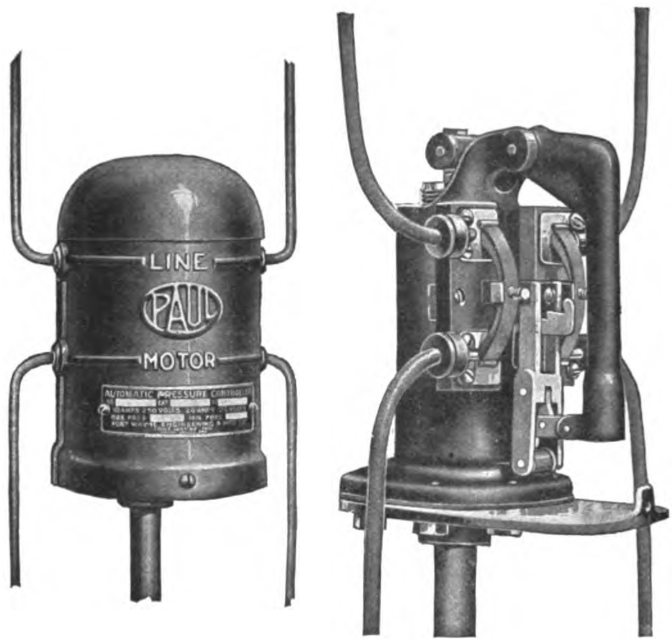
### Standard and Special Fittings

The suction as well as the discharge pipes must always be installed with a union next to the pump in order that the pump may be conveniently disconnected or taken apart without disturbing the piping. On the suction side the union is placed next to the strainer which is never disconnected except for the purpose of cleaning out. On the discharge side the following fittings are used in the order mentioned: A union next to pump, a water

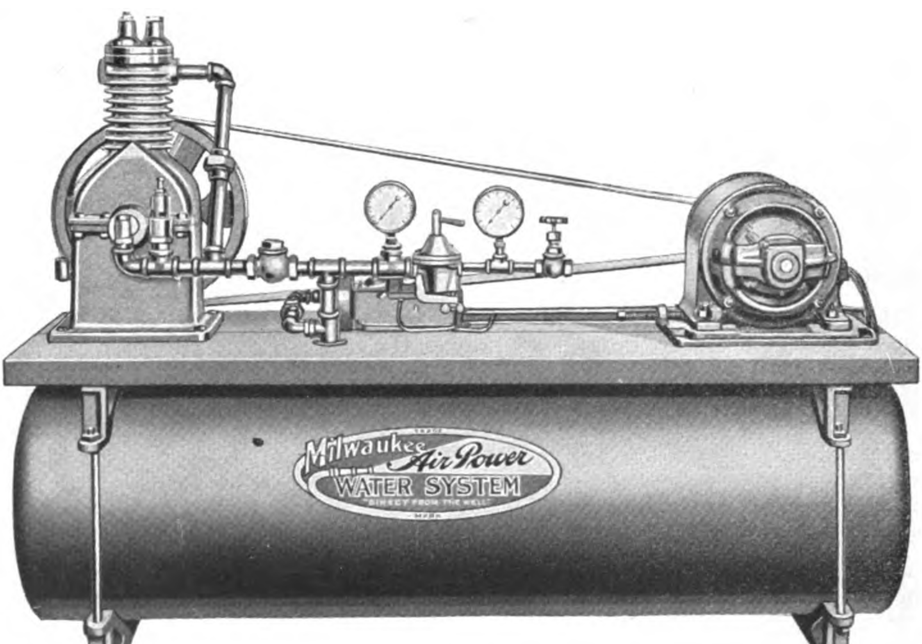
***These tables all refer to "Paul" pumps (Fort Wayne Engineering & Mfg. Co.) but may be used as a basis for figuring on installations generally.**



"National"
air lift system




**Views of Exterior and Working Mechanism of "Paul" controller**




**"Milwaukee Air Power" system complete with the exception of the "foot piece" that goes in the well**

relief valve, a stop valve and, with the "direct-from-the-well" attachment, also a check valve. Ordinary check valves are unnecessary with good pumps. the valves of which form the best possible check.

The friction loss in full size fittings is not serious, but bends should be avoided where possible. A 90 degree elbow, for instance, causes a friction equal to that in a straight pipe about 30 diameters long. A 1-inch ell is thus equivalent to 30 inches of 1-inch pipe. Some fittings, such as street elbows, choke the flow considerably and should not be used.

### Purpose of the Air Chamber

Water is incompressible and when confined in pipe acts as a solid body. Unless the pipe is short and the weight of the water small it may not follow the motion of the pump plunger but break away and cause water hammer, putting severe strains on the moving parts of the pump and causing knocks in the pipes. This is a common occurrence in water-logged pumps and to avoid it every pump is provided with an air chamber on the suction side as well as on the discharge side. Air in these chambers furnishes the cushion necessary to insure a steady, uninterrupted flow of water in the pipes and to permit the pump cylinder to fill at every stroke.

The air chambers on the pump are generally of sufficient size to take care of normal, short lengths of piping, but with long pipe lines it is necessary to provide extra air chambers near the pump which preferably should have gauge glasses to show the amount of air in them. Standard cast iron air chambers so provided can be had from the manufacturers. Extra air chambers may also be made up by simply installing a capped piece of pipe vertically on a tee in the line, making it about 30 pipe diameters high. Such air chambers should be installed wherever a knock or water hammer develops in the pipe line, and special care should be used to make them absolutely air-tight, as otherwise they are useless.

In long pipe lines in which the weight of water is considerable, a severe stress is produced by "water ram" if the flow is abruptly stopped by the closing of a valve or faucet. The line will often spring a leak or the fixtures are damaged. Here it is again necessary to provide an air chamber at the end of the line to absorb the force of the water and bring it to a gradual stop.

### Wiring of the Motor Circuit

In order to secure proper service it is important that the electric motors are correctly wired to get the voltage at the motors necessary to develop their normal starting "pull" and horsepower. Most motor troubles are due to an overloaded circuit or wires too small, or both. Table V, wiring data, gives the correct size of wires and fuses to use with various sizes of pumps.

The motors used are of a type not liable to interfere with the lights if connected to the lighting circuit, in the smaller sizes, but it is always preferable to install a separate line for the water system. The voltage at the pump motor should always be tested at moment of starting up and while running. If found low, a separate branch circuit should be run to it before the pump is put into regular service under automatic control. Always provide a hand switch for the pump motor. All motors on pumps must run in the direction called for by the manufacturer's instructions. This must be checked up in every case.

If the motor has been properly wired and the current tested as described, it will run the pump without any trouble and requires very little attention. Directions applying to the several types of motors are in some cases supplied by the motor manufacturers and attached to the motors.

The commutator will collect dirt in time and should then be cleaned in the usual way by fine sandpaper while running. The brushes will also wear

down after long service and need replacing. See under heading "Care of Generators and Motors."

### Failure Through Loss of Priming

If air enters the suction side of a pump the water recedes, air enters the pump cylinder, the pump becomes unprimed and must be reprimed. It is plain that a pump cannot lose its priming unless there is an air leak somewhere on the suction side.

When the pump was first installed and primed itself there was no pressure on the discharge side but when required to reprime itself the pressure in the system is behind the discharge valve and the pump is required to compress the air drawn from the suction pipe high enough to force the discharge valve open against this pressure. With moderately high suction lifts most pumps with valves and suction pipe in good condition will readily reprime but with very high lifts the air is so diluted that most will fail to reprime unless the pressure on the discharge side is relieved.

The proper remedy in such cases is to remedy the leak, but when this cannot be done the water can be held up to the pump by installing a tight check valve or a foot valve in the suction pipe. The best valves obtainable should be used, preferably with renewable soft seats.

### Automatic Priming Devices

When a pump on a very high suction lift with an air leak that cannot be eliminated refuses to reprime itself, automatic priming devices, consisting of a by-pass from the discharge side to the suction side of the pump in connection with a check valve can be obtained from some manufacturers. The small amount of water permitted to re-enter the suction pipe eliminates any clearance space in the pump which is thereby able to get rid of all air entering and reprime itself under the most unfavorable conditions.

With the stop cock in by-pass closed the pump is first primed by relieving the discharge pressure, and when it has picked up water the cock is opened and left open. The only condition for the proper operation of the device is that water and not air enters the by-pass. It must, therefore, be connected to a low point of the pipe which cannot form an air pocket, from a tee pointing downwards or from the tank.

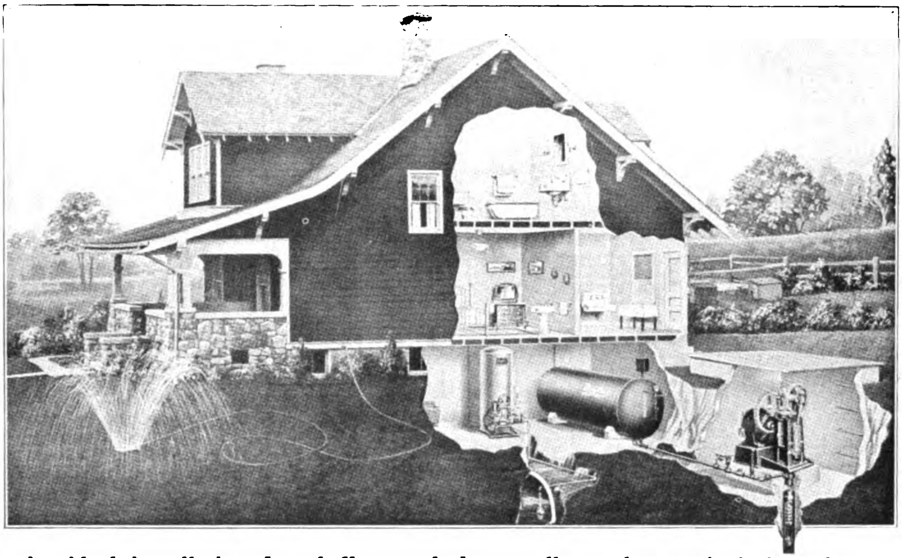
This is an emergency measure used only where the circumstances otherwise would make the use of a suction pump impossible or in cases where the water in a well recedes to a point where a deep well pump would be proper.

### Air Charging and Water Level in Tanks

With pneumatic storage tanks it is necessary to charge air more or less often, depending upon local conditions, to insure quiet, satisfactory operation of the pump. With normal suction lifts the water sometimes liberates enough air to keep the air chambers supplied and in exceptional cases more air than necessary, but with negative suction heads the air charging must be attended to regularly.

A pneumatic storage tank is to the water system as a whole what the air chambers are to the pump. Its purpose is to give flexibility to the system by storing a quantity of water under pressure available for service independently of the capacity of the pump. The storage capacity depends upon the size of the tank and the proportion of air and water in the tank as indicated by the gauge glass. In a water-logged tank the storage capacity is reduced, causing the pump to operate more often. To increase the storage capacity, air must be charged into the tank through the pump. The gauge glass is placed so that good service is obtained by keeping the water level at about the middle of the glass when the pressure is up and the pump stops.

The charging of a tank with air takes much more time than filling it with water and the progress is indicated by the pressure gauge only. If the



**An ideal installation for shallow and deep well supply, particularly valuable where the main supply is hard water**

pump is small and the tank large it is well to cool off the pump during charging by allowing it occasionally to pick up water for a few strokes and to do the charging against the lowest tank pressure.

### Storage Capacity of Pneumatic Pressure Tanks

Table IV gives the working capacity of pressure tanks and shows the amount of water available from storage between different highest and lowest working pressures. It can also be used for calculating sizes of tanks necessary to obtain a desired amount of storage capacity and for various other purposes as illustrated by several examples. The table is based on tanks two thirds full of water at highest pressure; if one half full, the storage capacity of 50 per cent. greater than given by the table.

### Automatic Water Service

By "automatic service" is meant that the pump automatically maintains a water pressure between fixed limits so that water under pressure always is obtainable at the faucets. This is accomplished by storing a suitable quantity of water in a pneumatic tank under air pressure and by providing an automatic electric controller operated by the pressure and set to start and stop the pump at certain low and high pressures in the tank. By such storage the water is improved due to oxidization of any foreign matter and as the contents of the tank usually change several times a day the water is always cool and fresh. For ordinary service it is customary to set the controller to start the pump at 20 lb. pressure and stop it at 40 lb. With this standard setting water is at all times available at an elevation of about 45 feet above the pump. Controllers working between 30 and 50 lb. pressure, for a maximum elevation of about 70 feet may also be had, while manufacturers furnish controllers to meet unusual conditions on special order.

### Pressure Range of Automatic Controller

Pressure controllers are adjusted to operate at the pressures listed and marked on their nameplates as closely as possible. Due to the location of the controller, springs used and other variable conditions they will at times show some variation of range. The service is, however, not affected thereby

*Courtesy Dayton Pump & Mfg. Co.*

to an appreciable extent as long as the pressures are within the intended limits.

A controller will show a shorter range by cutting out ahead of time if the pump or system is water-logged, due to excessive variation of pressure at the discharge of the pump. Air charging will remedy such a condition.

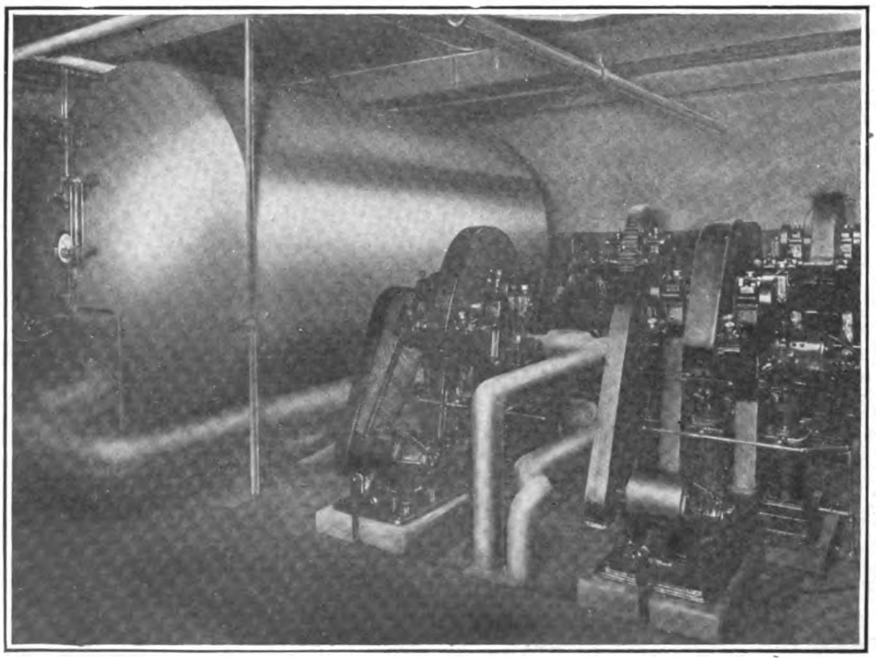
Should a controller at any time fail to operate at either end of the range, it is well to disconnect and clean out the pressure tube. If repairs are needed, the controller should preferably be sent to the factory for adjustment and attention. The pump can be operated by the hand switch in the meantime. Under no circumstances should an attempt be made to lubricate the interior parts of the controller on account of the rubber diaphragm.

### "Water-direct-from-the-well" Device

The extra parts necessary to provide this are a special check valve between pump and tank and an air seal on the discharge side, with necessary fittings. The check holds the tank pressure back and thus permits the pressure on the discharge side of the pump to drop immediately when the fresh water faucet is opened, which in turn causes the controller to start the pump. The water entering the fresh water pipe is then delivered direct from the well, and the feature is used only on pumps installed on wells which give good, cold drinking water.

The check valve has a small by-pass for the purpose of maintaining tank pressure at the controller thereby preventing the pump from starting up periodically for a few strokes at a time in case the fresh water faucet drips or the pipe has a siight leak. The air seal, placed next to the pump discharge, with the body hanging downwards, forms a trap which prevents any air from entering the fresh water line when air is being charged.

It must be remembered that the opening of a fresh water faucet immediately starts the pump, even if only a glass full is needed, as if the system were entirely water-logged. In order not to abuse the pump and motor it is, therefore, well not to form a habit of using the fresh water faucet when



**Installations of this kind can be sold to schools and institutions**

*Courtesy Plumbers' Trade Journal.*

the regular supply would do just as well, and to open the faucet wide enough to draw the capacity of the pump, which otherwise will start and stop several times while the faucet is open. This feature should never be placed on a water system run by a plant with a very small battery as it will discharge the latter needlessly.

### Replacing Packing

The packing used generally consists of cup leathers or flanged leathers which are specially impregnated and bear against polished parts of brass or bronze, so that they give unusually long service before wearing to a point where they become leaky and must be replaced. When handling leather packing it is important not to burr or bend the working edge of the leather and to make sure that all parts are free from dirt or grit. Unlike ordinary soft packing a leather packing, if leaking, cannot be tightened by applying pressure provided the gland is tight enough to seat the packing at bottom of stuffing box and on the support rings. All pumps have a drain for water that may leak past the packing, which may be piped away, but the drain must never be plugged. That will not eliminate the leak but will force the water into the crank case of the pump when it mixes with the oil and interferes with the lubrication.

**Table II—Greatest Vertical Suction Lift in Feet of Pumps Through Various Sizes and Lengths of Suction Pipe in Fair Interior Condition**

| Capacity Gallons Hour | Size of Suction Pipe In. | Total Length of Suction Pipe in Feet Short | 50 | 100 | 150 | 200 | 250 | 300 | 400 |
|---|---|---|---|---|---|---|---|---|---|
| | ½ | 20 ft. | 17.8 | 15.6 | 13.4 | 11.2 | 9.0 | 6.8 | 2.4 |
| 100 | ¾ | 20 ft. | 19.5 | 18.9 | 18.4 | 17.8 | 17.3 | 16.8 | 15.7 |
| | 1 | 20 ft. | 19.8 | 19.6 | 19.4 | 19.3 | 19.1 | 18.9 | 18.5 |
| | ¾ | 21 ft. | 19.3 | 17.7 | 16.0 | 14.4 | 12.7 | 11.1 | 9.8 |
| 180 | 1 | 21 ft. | 20.5 | 20.0 | 19.5 | 19.0 | 18.5 | 18.0 | 17.0 |
| | 1¼ | 21 ft. | 20.9 | 20.7 | 20.6 | 20.4 | 20.3 | 20.1 | 19.8 |
| | 1 | 22 ft. | 20.2 | 18.4 | 16.6 | 14.8 | 13.0 | 11.2 | 7.6 |
| 360 | 1¼ | 22 ft. | 21.5 | 21.1 | 20.6 | 20.2 | 19.7 | 19.2 | 18.3 |
| | 1½ | 22 ft. | 21.8 | 21.6 | 21.4 | 21.4 | 21.0 | 20.7 | 20.3 |
| | 1¼ | 23 ft. | 21.4 | 19.7 | 18.1 | 16.4 | 14.8 | 13.1 | 9.8 |
| 720 | 1½ | 23 ft. | 22.3 | 21.5 | 20.8 | 20.0 | 19.3 | 18.5 | 17.0 |
| | 2 | 23 ft. | 22.8 | 22.5 | 22.3 | 22.1 | 21.9 | 21.6 | 21.2 |
| | 2 | 24 ft. | 23.2 | 22.4 | 21.6 | 20.8 | 20.0 | 19.1 | 17.5 |
| 1,440 | 2½ | 24 ft. | 23.7 | 23.4 | 23.1 | 22.8 | 22.5 | 22.1 | 21.5 |
| | 3 | 24 ft. | 23.9 | 23.8 | 23.7 | 23.6 | 23.5 | 23.4 | 23.2 |

Note: Pumps are self-priming at suction lifts given by table and with free discharge. If installed with air-tight suction lines, so as to stay primed, they may be used on slightly higher lifts but not exceeding 25 feet with short suction pipes.

These and other rates under tables, as well as specific references in the text are to "Paul" Pumps and Systems (Ft. Wayne Engineering & Mfg Co., Ft. Wayne, Ind.) but may be taken as a basis for estimating installations where high grade equipment is to be used.

**Table III—Friction Losses in Lb. per Sq. In. in Various Sizes and Length of Piping in Fair Interior Condition Discharging the Full Capacity of Pumps Listed**

| Capacity Gallons Hour | Size of Pipe Inches | Total Length of Pipe in Feet 100 | 200 | 300 | 500 | 1,000 | 2,000 | 3,000 | 5,280 |
|---|---|---|---|---|---|---|---|---|---|
| | ½ | 1.9 | 3.8 | 5.7 | 9.5 | 19.0 | 38 | 57 | 100 |
| 100 | ¾ | 0.5 | 0.9 | 1.4 | 2.3 | 4.7 | 9 | 14 | 25 |
| | 1 | 0.1 | 0.3 | 0.4 | 0.7 | 1.4 | 3 | 4 | 8 |
| | ¾ | 1.4 | 2.8 | 4.2 | 7.1 | 14.1 | 28 | 42 | 74 |
| 180 | 1 | 0.4 | 0.9 | 1.3 | 2.1 | 4.3 | 9 | 13 | 23 |
| | 1¼ | 0.1 | 0.2 | 0.3 | 0.5 | 1.1 | 2 | 3 | 6 |
| | ¾ | 5.1 | 10.2 | 15.3 | 25.6 | 5.12 | 102 | 153 | 270 |
| 360 | 1 | 1.6 | 3.1 | 4.7 | 7.8 | 15.5 | 31 | 47 | 82 |
| | 1¼ | 0.4 | 0.8 | 1.2 | 1.9 | 3.9 | 8 | 12 | 21 |
| | 1 | 5.6 | 11.2 | 16.8 | 28.1 | 56.2 | 112 | 168 | 297 |
| 720 | 1¼ | 1.4 | 2.8 | 4.2 | 7.1 | 14.1 | 28 | 42 | 74 |
| | 1½ | 0.7 | 1.3 | 2.0 | 3.3 | 6.6 | 13 | 20 | 35 |
| | 1½ | 2.4 | 4.8 | 7.2 | 12.0 | 24.0 | 48 | 72 | 127 |
| 1,440 | 2 | 0.7 | 1.4 | 2.1 | 3.5 | 7.0 | 14 | 21 | 37 |
| | 2½ | 0.3 | 0.6 | 0.9 | 1.4 | 2.9 | 6 | 9 | 15 |

Note: Each 90 degree elbow in suction or discharge line causes a friction loss equal to the loss in straight pipe 30 diameters long.

Note 2. Pumps are tapped for standard pipes of smallest size listed. With larger pipes use a reducer near the pump.

Note 3. When suction or discharge lines exceed 50 feet in length, use on extra air chamber near the pump, corresponding to size of pipe.

**Table IV—Working Capacity of Pressure Tanks Based on 2/3 Full of Water and 1/3 Full of Air at Highest Tank Pressure**

Highest Tank Pressure Pounds

These figures give working capacity of pressure tanks in gallons for each 100 gallons total capacity, between pressures indicated

| Lowest Tank Pressure Pounds | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 8 | 25 | 41 | 58 | | | | | | |
| 10 | 0 | 13 | 26 | 40 | 53 | 66 | | | | |
| 15 | | 5 | 16 | 28 | 39 | 50 | 61 | | | |
| 20 | | 0 | 9 | 19 | 29 | 38 | 48 | 57 | | |
| 25 | | | 6 | 12 | 21 | 29 | 37 | 46 | 54 | 62 |
| 30 | | | 0 | 7 | 15 | 22 | 30 | 37 | 44 | 52 |
| 35 | | | | 3 | 10 | 17 | 23 | 30 | 37 | 43 |
| 40 | | | | 0 | 6 | 12 | 18 | 24 | 30 | 36 |
| 45 | | | | | 3 | 8 | 14 | 19 | 25 | 30 |
| 50 | | | | | 0 | 5 | 10 | 15 | 20 | 25 |

Note: With tank only ½ full of water and ½ full of air at highest tank pressure, the working capacity is increased 50 per cent.

Example 1: A 630 gallon tank, 36″ x 12′, is 2/3 full of water under a pressure of 60 pounds gauge. How much water can be drawn lowering pressure to 20 pounds gauge?

Between 60 and 20 pounds table gives 38 per cent. Therefore $0.38 \times 630 = 239$ gallons can be drawn.

Example 2: What size tank must be used to deliver 500 gallons of water from storage when 2/3 full under 80 pounds pressure, if lowest water pressure must be 30 pounds?

Between 80 and 30 pounds table gives 37 per cent. Tank must therefore be $500 \div 0.37 = 1{,}350$ gallon capacity or about 48″ x 14′.

### TABLE "V"—WIRING DATA FOR WATER SYSTEMS*

**110-220 Volts D.C. and A.C.; 32 Volts D.C.**

| | | | Transf. to Meter 200 Feet or Less | | | | Meter to Motor 100 Feet or Less | | | | Plant-Motor 100 Feet or Less |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pump | Motor H.P. | | 110V. 60-1 | 220V. 60-1 | 110V. D.C. | 220V. D.C. | 110V. 60-1 | 220V. 60-1 | 110V. D.C. | 220V. D.C. | 32V. D.C. |
| 97 | ⅛ | Wire | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 9 |
| "K" | | Fuse | 5 A | 5 A | 5 A | 5 A | 5 A | 5 A | 5 A | 5 A | 15 A |
| 95-96 | 1/6 | Wire | 12 | 14 | 12 | 14 | 14 | 14 | 14 | 14 | 7 |
| "FK" | ¼ | Fuse | 10 A | 5 A | 10 A | 5 A | 10 A | 5 A | 10 A | 5 A | 20 A |
| 82 | ½ | Wire | 9 | 10 | 9 | 10 | 12 | 14 | 12 | 14 | 3 |
| "G" | | Fuse | 15 A | 10 A | 15 A | 10 A | 15 A | 10 A | 15 A | 10 A | 60 A |
| 83 | 1 | Wire | 6 | 9 | 6 | 9 | 9 | 12 | 9 | 12 | |
| "G" | | Fuse | 30 A | 20 A | 30 A | 20 A | 30 A | 20 A | 30 A | 20 A | |
| 84 | 2 | Wire | 3 | 6 | 3 | 6 | 6 | 9 | 6 | 9 | |
| "G" | | Fuse | 60 A | 30 A | 60 A | 30 A | 60 A | 30 A | 60 A | 30 A | |
| 50 | ½ | Wire | 9 | 10 | 9 | 10 | 12 | 14 | 12 | 14 | 3 |
| "H" | | Fuse | 15 A | 10 A | 15 A | 10 A | 15 A | 10 A | 15 A | 10 A | 60 A |
| 51 | ¾ | Wire | 7 | 10 | 7 | 10 | 10 | 12 | 10 | 12 | 1 |
| "H" | | Fuse | 20 A | 15 A | 20 A | 15 A | 20 A | 15 A | 20 A | 15 A | 60 A |
| 53 | 1 | Wire | 6 | 9 | 6 | 9 | 9 | 12 | 9 | 12 | |
| "H" | | Fuse | 30 A | 20 A | 30 A | 20 A | 30 A | 20 A | 30 A | 20 A | |
| 54 | 2 | Wire | 3 | 6 | 3 | 6 | 6 | 9 | 6 | 9 | |
| "H" | | Fuse | 60 A | 30 A | 60 A | 30 A | 60 A | 30 A | 60 A | 30 A | |
| 56 | 3 | Wire | 1 | 4 | 1 | 4 | 4 | 6 | 4 | 6 | |
| "H" | | Fuse | 60 A | 60 A | 60 A | 60 A | 60 A | 60 A | 60 A | 60 A | |

Drop of Voltage in Starting not over 8 Volts.
For each 100 Feet Additional Wire use One Gauge Heavier.
*Contributed by Fort Wayne Engineering & Mfg. Co., Fort Wayne, Ind.

### Weight of Liquids at 60° Fahr.

| Material | Specific Gravity | Lbs. per Cu. Ft. | Lbs. per U.S.Gal. |
|---|---|---|---|
| Pure Water 62° | 1. | 62.355 | 8.33 |
| Sulphuric Acid | 1.841 | 115.8 | 15.48 |
| Carbon Bisulphide | 1.26 | 78.55 | 10.5 |
| Nitric Acid | 1.217 | 76.0 | 10.16 |
| Hydrochloric Acid | 1.2 | 74.23 | 9.93 |
| Water, sea | 1.03 | 63.95 | 8.55 |
| Tar | 1.015 | 62.82 | 8.4 |
| Oil, Linseed | .94 | 58.72 | 7.85 |
| Oil, Petroleum | .878 | 55.3 | 7.39 |
| Oil, Turpentine | .87 | 53.55 | 7.16 |
| Naphtha | .848 | 52.35 | 7. |
| Alcohol, Commercial | .833 | 51.85 | 6.93 |
| Sulphuric Ether | .72 | 44.8 | 6.0 |

Authorities: Kent, Foster, etc.

# Weight, Pressure, Velocity, etc., of Water

A Gallon of water (U. S. Standard) contains 231 cubic inches and weighs 8⅓ pounds.

A Cubic Foot of water contains 7½ gallons, or 1728 cubic inches, and weighs 62½ pounds.

A "Miner's Inch" is a measure for the flow of water, and is the amount discharged through an opening 1 inch square in a plank 2 inches in thickness, under a head of 6 inches to the upper edge of the opening; and this is equal to 11.625 U. S. Gallons per minute.

The height of a column of fresh water, equal to a pressure of 1 pound per square inch, is 2.31 feet.

A column of water 1 foot high exerts a pressure of .433 pounds per square inch.

The capacity of a cylinder in gallons is equal to the length in inches multiplied by the area in inches, divided by 231 (the cubical contents of one U. S. gallon in inches).

The velocity in feet per minute, necessary to discharge a given volume of water in a given time, is found by multiplying the number of cubic feet of water by 144, and dividing the product by the area of the pipe in inches.

The area of a required pipe, the volume and velocity being given, is found by multiplying the number of cubic feet of water by 144, and dividing the product by the velocity in feet per minute. The area being found, the diameter is obtained by the table of areas.

Doubling the diameter of a pipe increases its capacity four times.

The friction of liquids in pipes increases as the square of the velocity.

The horse-power necessary to elevate water to a given height is found by multiplying the weight of the water elevated per minute, in pounds, by the height in feet, and dividing the product by 33,000.

Pressure of Water Due to Its Weight.—The pressure of still water in pounds per square inch against the sides of any pipe, channel, or vessel of any shape whatever, is due solely to the "head" or height of the level surface of the water above the point at which the pressure is considered, and is equal to .43302 lb. per square inch for every foot of head, or 62,335 lb. per square foot for every foot of head (at 62° F.).

The pressure per square inch is equal in all directions, downwards, upwards, or sideways, and is independent of the shape or size of the containing vessel.

The pressure against a vertical surface, as a retaining-wall, at any point is in direct ratio to the head above that point, increasing from 0 at the level surface to a maximum at the bottom. The total pressure against a vertical strip of a unit's breadth increases as the area of a right-angled triangle whose perpendicular represents the height of the strip and whose base represents the pressure on a unit of surface at the bottom; that is, it increases as the square of the depth. The sum of all the horizontal pressures is represented by the area of the triangle, and the resultant of this sum is equal to this sum exerted at a point one-third of the height from the bottom. (The center of gravity of the area of a triangle is one-third of its height.)

The horizontal pressure is the same if the surface is inclined instead of vertical.

(For an elaboration of these principles see Trautwine's Pocket-Book, or the chapter on Hydrostatics in any work of Physics. For dams, retaining-walls, etc., see Trautwine.)

The amount of pressure on the interior of walls of a pipe has no appreciable effect upon the amount of flow.

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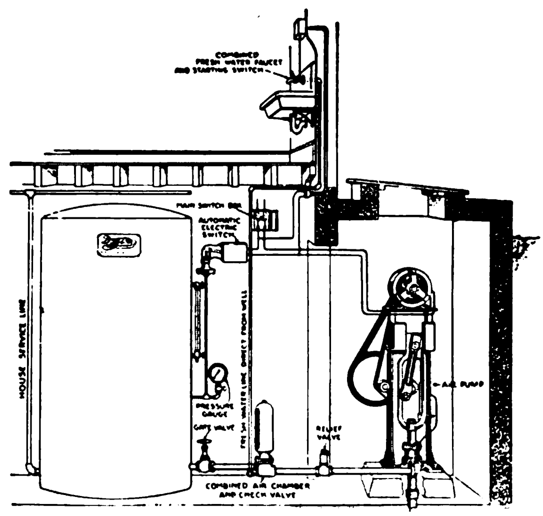
Buoyancy.—When a body is immersed in a liquid, whether it float or sink, it is buoyed up by a force equal to the weight of the bulk of the liquid displaced by the body. The weight of a floating body is equal to the weight of the bulk of the liquid that it displaces. The upward pressure or buoyancy of the liquid may be regarded as exerted at the center of gravity of the displaced water, which is called the center of pressure or of buoyancy. A vertical line drawn through it is called the axis of buoyancy or of flotation. In a floating body at rest a line joining the center of gravity and the center of buoyancy is vertical, and is called the axis of equilibrium. When an external force causes the axis of equilibrium to lean, if a vertical line be drawn upward from the center of buoyancy to this axis, the point where it cuts the axis is called the metacentre. If the metacentre is above the center of gravity the distance between them is called the metacentric height, and the body is then said to be in stable equilibrium, tending to return to its original position when the external force is removed.

Boiling-Point.—Water boils at 212° F. (100° C.) at mean atmospheric pressure at the sea-level, 14.7 lb. per square inch. The temperature at which water boils at any given pressure is the same as the temperature of saturated steam at the same pressure.

The Boiling-Point of Water May Be Raised.—When water is entirely freed of air, which may be accomplished by freezing or boiling, the cohesion of its atoms is greatly increased, so that its temperature may be raised at 50° above the ordinary boiling-point before ebullition takes place. It was found by Faraday that when such air-freed water did boil, the rupture of the liquid was like an explosion. When water is surrounded by a film of oil, its boiling temperature may be raised considerably above its normal standard. This has been applied as a theoretical explanation in the instance of boiler explosions.

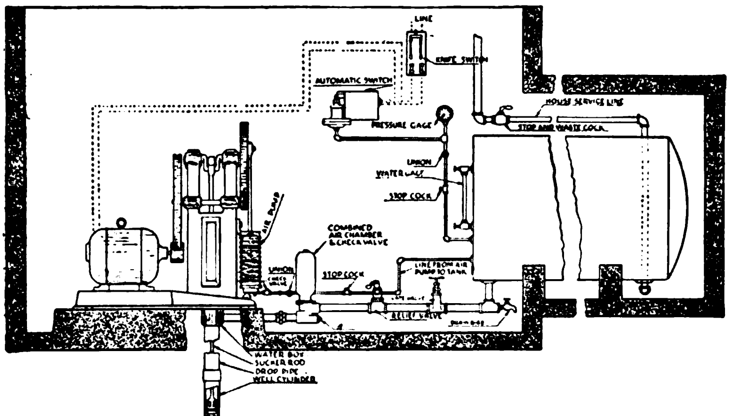
The freezing-point also may be lowered, if the water is perfectly quiet, to 10° C., or 18° Fahrenheit, below the normal freezing-point (Hamilton Smith, Jr., on Hydraulics, p. 13). The density of water at 14° F. is .99814, its density at 39.1° F. being 1, and at 32° F., .99987.

Freezing-Point.—Water freezes at 32° F., at the ordinary atmospheric pressure, and ice melts at the same temperature. In the melting of 1 pound of ice into water at 32° F., about 142 heat units are absorbed, or become latent; and in freezing 1 pound of water into ice a like quantity of heat is given out to the surrounding medium.




**Excellent layout of installation of small deep well type system. A study of these diagrams will save expensive mistakes**

*Courtesy Dayton Pump & Mfg. Co.*



**A great deal of valuable information can be gained by the dealer from a study of these layouts in connection with the accompanying text which gives all essential rules for installing water systems**

**A larger deep well type installation**

*Courtesy Dayton Pump & Mfg. Co.*

Sea-water freezes at 27° F. The ice is fresh. (Trautwine.)

Ice and Snow.—(From Clark.) 1 cubic foot of ice at 32° F., weight 57.50 lb.; 1 lb. of ice at 32° F. has a volume of .0174 cubic foot=30.067 cubic inches.

Relative volume of ice to water at 32° F., 1.0855, the expansion in passing into the solid state being 8.55 per cent. Specific gravity of ice=0.922, water at 62° F., being 1.

At high pressures the melting point of ice is lower than 32° F., being at the rate of .0133° F. for each additional atmosphere of pressure.

The specific heat of ice is .504, that of water being 1.

One cubic foot of fresh snow, according to humidity of atmosphere: 5 lb. to 12 lb. One cubic foot of snow moistened and compacted by rain: 15 lb. to 50 lb. (Trautwine.)

Compressibility of Water.—Water is very slightly compressible. Its compressibility is from .000040 to .000051 for one atmosphere, decreasing with increase of temperature. For each foot of pressure distilled water will be diminished in volume .0000015 to .0000013. Water is so incompressible that even at a depth of a mile, a cubic foot of water will weigh only about a half pound more than at the surface.

Water is composed of two gases, hydrogen and oxygen, in the ratio of two volumes of the former to one of the latter. It is never found pure in nature, owing to the readiness with which it absorbs impurities from the air and soil.

One foot of water column at 39.1° F.=62.425 lb. on the square foot.

One foot of water column at 39.1° F.=0.4335 lb. on the square inch.

One foot of water column at 39.1° F.=0.0295 atmospheric pressure.

One foot of water column at 39.1° F.=0.8826 in. mercury column at 32° F.

One foot of water column at 39.1° F.=773.3 foot of air column at 32° F. and atmospheric pressure.

One pound pressure on square foot=0.01602 foot water column at 39.1° F.

One pound pressure on square inch=2.307 foot water column at 39.1° F.

One atmospheric pressure=29.92 in mercury column=33.9 foot water column.

One inch of mercury column at 32° F.=1.133 foot water column.

One foot of air column at 32° F. and 1 atmospheric pressure=0.001293 foot water column.

1—California Miners' inch (New)=11.22 gallons per minute.

# Washing Machines

THE live dealer will find that the washing machine will prove to be one of the most valuable appliances on the market as a means of adding to his annual income, but before tying himself up on an agency proposition it will well repay the time taken to make a careful study of washing machines and their merits. In the same sense that all men are good but some are better than others, all washing machines are good in that any mechanical method of doing this laborious task is a great improvement over hand labor. A real good washing machine, however, not only saves labor but also saves the severe wear and tear of clothing inseparable from hand washing and it is so designed and built that it will render satisfactory service continuously for a long time without any adjustments or repairs.

Dirt in clothing takes the form of particles of foreign matter that have lodged between the meshes of the fabric and the only way to dislodge it and reversing, agitates the clothes, forcing the soapy water through the fabric, In this sense, all washing machines operate on the same principles that they are designed to force warm, soapy water through the garment. It is only in applying this principle that they differ.

### Types of Washing Machines

There are four types of washing machines most frequently found on the market, all of them efficient as washers.

**The cylinder type** has an outer tub with an inner cylinder or drum of metal or wood in which the clothes to be washed are placed. This cylinder revolves and on some machines reverses to obtain the necessary agitation. This revolving lifts the clothes out of the water and drops them back into it, thus flushing the water through the fabric of the cloth.

**The oscillator or rocker type** has a metal or wood tub in which the clothes and soapy water are placed. The tubs rock back and forth, accomplishing the cleaning of the clothes, by tilting the tub or similar means by which the hot suds are forced back and forth through the fiber of the cloth.

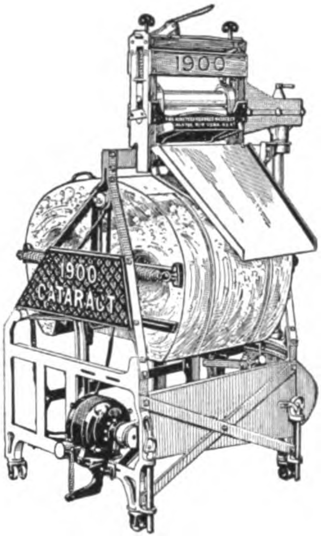
**The agitator or dolly type** has a tub of wood or metal usually made with corrugated sides and bottom and an agitator or disc called the dolly which fits down onto the clothes. This agitator grasps the clothes and turning and reversing, agitates the clothes, forcing the soapy water through the fabric, thus cleaning them.

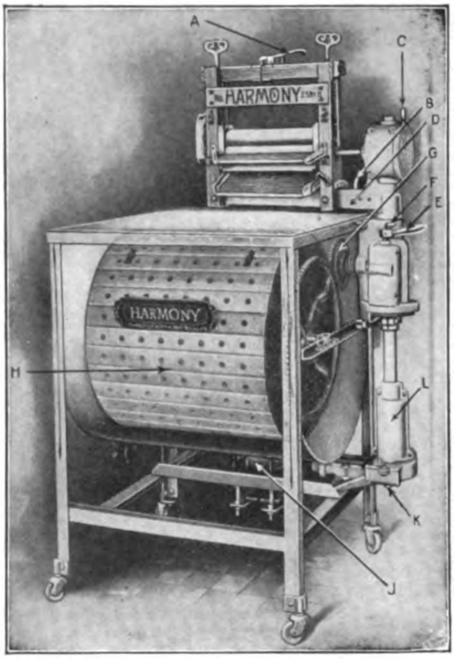
**Vacuum type.** In these machines there is an outer tub, equipped with moving cups or cones, resembling inverted funnels. These cups operate up and down forcing the water through the fabric on the down stroke, while on the up stroke the suction draws the water through the clothes.

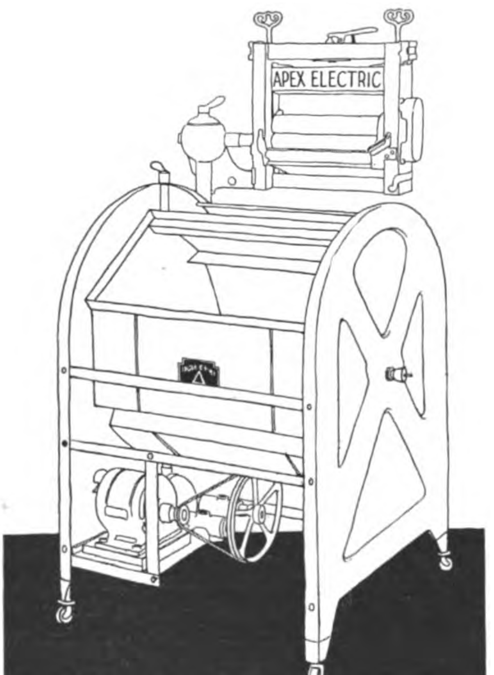
Every one of the scores of different makes of washing machines now on the market belongs to one of the above four types, but naturally all are not equally good machines. Some are the products of companies who have put in a quarter of a century or more in developing the washing machine to its present state of efficiency while others were placed on the market only last month. This does not necessarily imply that the late comer is an inferior machine on that account, but before tying up definitely with any particular manufacturer the dealer would do well to make a thorough examination of the types of machines that appeal to him. As in the case of a farm light plant, the dealer should be thoroughly sold himself on the merits of the washing machine before he takes it on because he is then in a position to recommend it honestly and back it with all the sales enthusiasm he can muster. It is always much easier for anyone to sell an article when he is thoroughly "sold" on it himself.

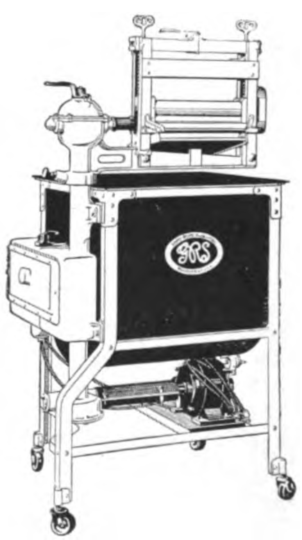
The accompanying illustrations show the different methods of operation of the various types of machines referred to above. As the manufacturers'

association says in its literature, "all of the various types of machines are efficient clothes washers." Naturally every manufacturer regards his own product as infinitely superior to any other and, when the dealer hooks up with him as his representative, he should be in the same frame of mind. He should be selling what he considers to be the very best washing machine made.



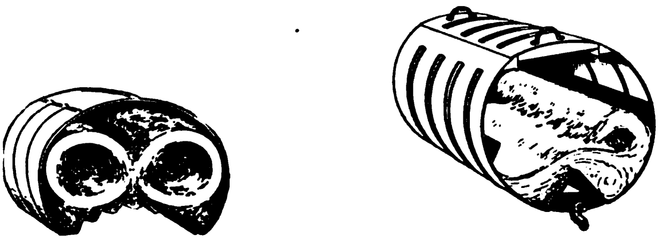



**Some representative types of cylinder and oscillating washing machines**

It's up to you as a dealer to pick out that machine to your own satisfaction because then you know you will be able to sell it.

### Demonstration Method Most Effective

Most things in this field right from the farm light and power plant itself down to the smallest appliance can be sold more effectively by an actual demonstration than in any other way and the washing machine stands at the head of the list when it comes to sales by demonstration. It's a case of action speaking much louder than words and telling the farmer's wife that the machine will save her three hours out of the four now devoted to doing the weekly wash and at the same time transform it from a back-breaking piece of drudgery into light and easy work doesn't mean anything like as much to her as giving her a sample of the goods—doing an actual week's wash. Where it isn't easy or convenient to get the prospect into your store or if your quarters do not afford the space and accommodation necessary for a good sized demonstration on a large scale, you will have to be content with taking a machine around to some of your best prospects and operating it from a plant on your truck. Then you can sell a washing machine and a farm light plant to run it, as some dealers have already done very successfully. If your prospect already had a plant in operation, as will usually be the case, it's up to you to take the washing machine out and actually



**Illustrating principle of operation of oscillating type washing machine. "1900" washer at left; Coffield at right**

superintend the operation. There's no use of your leaving the machine at the house saying you will call back for it two or three days later. You have to be on the job at the time and that is your opportunity to combine a whole lot of strong sales talk with the actual demonstration.

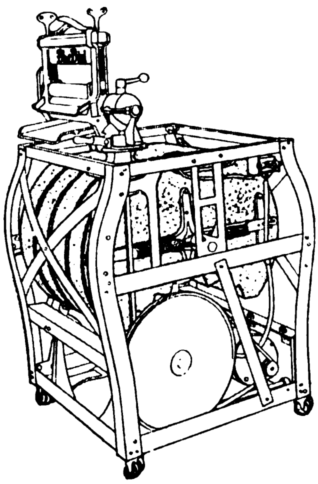
### A Large Scale Demonstration

The demonstrations by appointment at the farmer's house as mentioned above are effective in making sales but they take a lot of time. You can combine a lot of them into one day and make them all much more effective by advertising a special wash day. Send out a letter offering to every owner of one of your farm light plants to do a week's washing for the family, if it is delivered to your store on a certain day and taken away again as soon as washed. Such an offer will receive a lot of takers if you make your special wash day coincide with the farmer's usual market day, Saturday. It is only necessary to make one condition—that the owner of the clothes attend the demonstration in person and watch the operation from beginning to end.

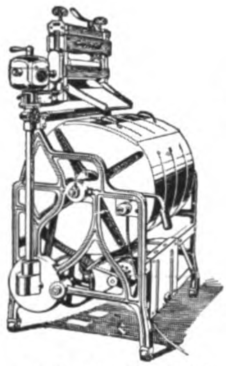
In the course of a day it should be possible to wash a dozen or more good sized batches of clothes and deliver them to their owners to take home for drying. Don't make any more appointments than you can handle in a day conveniently because the job must be well done in each case to make the demonstration successful. It looks like getting into the laundry business on a large scale but it is a certain way of making sales of washing machines. In all probability, you will have more applications than you can take care of in any one day, so that you can hold a special wash day once or twice a month, but don't do any washing for the same farmer's wife more than once.

The same idea can be carried out on a smaller scale by writing special personal letters to good prospects to whom it is not an easy matter to give a demonstration in their own homes. Offer to do a week's washing for these prospects on the same conditions as mentioned above, giving a time at which you know they usually come to town.

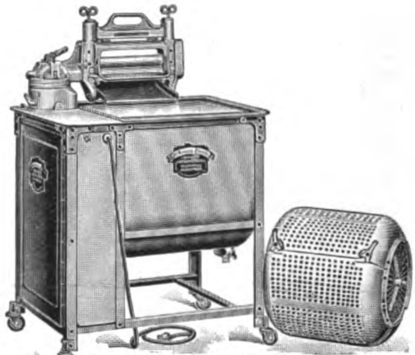
It's a good idea always to try to keep at least two or three machines in stock so that prompt deliveries may be made. This in addition to the machine used for demonstrating purposes. The mere fact that you are able to make delivery either the same day or the day after you receive the order often means a lot in making sales. It's also very important to keep a stock of replacement parts. Every machine has certain small parts subject to hard wear. They don't cost much but no one wants to have a machine put out of commission for lack of them during the time it takes to write the factory and get a reply. Ask your manufacturer to suggest a list of the most necessary parts so that you will be prepared to give the same kind of service on your washing machines as you do on your plants.



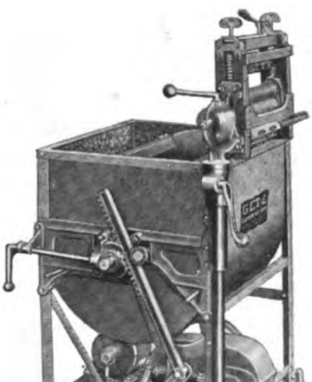
**"Blue Bird" Oscillating Machine**



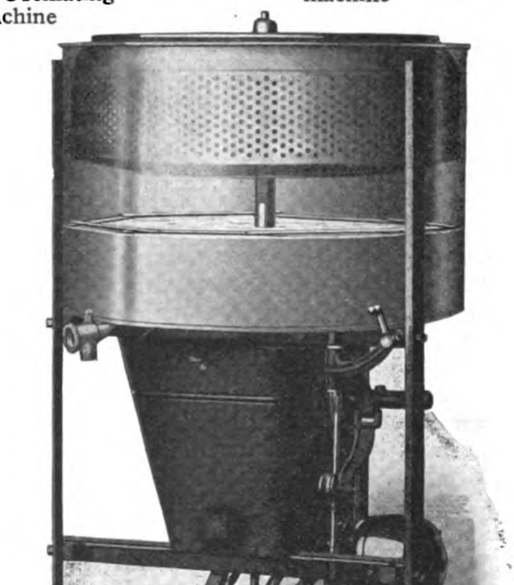
**Coffield Oscillating Machine**



A metal cylinder washing machine



**Getz "Power Washer"**



Laun-Dry-Ette vacuum type machine with **centrifugal dryer**

# Selling Fixtures, Accessories and Supplies

HAVE you entered the farm light field as a life-time job to which you intend to devote all of your energy from now on? Or have you just dropped into it as a side line with a view to clearing up all you can on quick commission and then dropping it? If the latter be true, you had better drop it right off because it isn't going to pay you any way you look at it but if you are in the business to stay and make a life-time success of it as every dealer should, you will find that a large part of this success depends upon your sales of additional equipment and appliances and if you are giving the right kind of service to your customers you will find ample opportunity to make the sales bring you in as much, if not more, than your annual commission on the sale of plants themselves. In the following pages we have listed a number of appliances and accessories of the smaller kind, noting whether it would be worth while for the dealer to carry stock or not.

### Selling and Stocking Lighting Fixtures

Lighting fixtures are apt to prove the most important items under the headings of accessories and supplies, but there are a good many problems connected with their sale. There are so many different types of lighting fixtures that the first thing the dealer is confronted with is the question of whether he shall carry a stock and how large a stock is necessary to make a success of his business. Every plant sale naturally brings with it a fixture sale as well as a wiring job. In many cases the dealer will sell a pretty complete set of fixtures together with the plant and the wiring job and in such cases, as well as those where the sales are made subsequent to the installation, the question is, how can the dealer present the subject of fixtures to the customer in the most convenient manner? It may be taken for granted that at the outset, not a great many dealers will be in a position to carry a stock comprehensive enough for sales purposes, but just as soon as he can do so, the dealer should fix up his store, demonstrating room or whatever he chooses to call it, with a few good fixtures that will not only light the store attractively but also serve as samples from which to sell.

### How Little Stock Can Be Carried?

For the expenditure of not over $150 to $200, the dealer can install samples representing a fairly representative line of fixtures, including two or three attractive reading lamps. All of them should be wired up and used, and not merely stuck around like so many random samples. Their chief purpose is to make your showroom attractive and well lighted, the fact that they will also serve as excellent samples being secondary. Many sales can be made on this small outlay, whether any actual stock is carried or not. It will probably pay any established dealer, however, to carry a small stock of the more commonly used types of side brackets, dining room fixtures and some reading lamps. So much for the stock that can be carried by the dealer who has a show room which he should make an attractive and well lighted rest room for his customers whenever they are in town.

### Fixture Sales on Calls

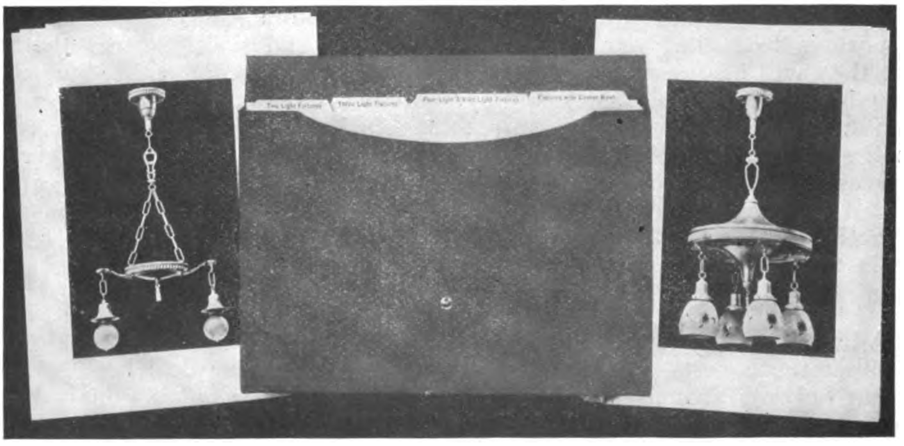
A large part of the sales made by every dealer will consist of those orders taken in the course of making service calls. The wise dealer will see to it that he gets around regularly to see his customers' plants in order to make sure that they are in working condition and remain so, rather than neglecting them until such time as the owner has to telephone him to come out and put the plant in running condition. Everyone of these service calls

can be made a sales call at the same time. Naturally it isn't possible to carry a stock of fixtures along but lots of fixtures can be sold from a catalogue. Many manufacturers put out special editions of catalogues designed just for this purpose. They give a comparatively small number of designs adapted to each room and so do not confuse the customer. Moreover, all of the fixtures listed in these special catalogues are offered completely wired. That is, the fixture is all ready to install and is complete, the fixtures have not been assembled. It is rather a mistake to show the customer too large and complete an assortment because it only tends to confuse him—or rather her, because the customer's wife will probably buy most of these items.

Realizing the difficulties that prevent the dealer both in carrying stock and in selling on the road, one manufacturer has devised an ingenious plan that makes it possible for the dealer to show a full line of fixtures in all finishes for the surprisingly small outlay of $7.50. This charge covers the cost of the exhibition portfolio with samples of the finishes in which all of the 160 or more fixture designs illustrated in the portfolio may be supplied. Each fixture is illustrated individually by reproductions from retouched photographs, while on the back of each picture is given the full details of the construction. The illustrations are all on loose sheets and the sheets are classified and indexed so that the dealer may pick out at once the exact design or range of designs he wishes to present to his prospect. There is also a set of sheets showing all the glassware supplies, in the natural colors, making it possible for the dealer to show first the picture of the complete fixture itself, then the finish of the metal and third the exact colors of the glassware. A complete price list makes it possible to quote the retail prices on any fixtures or sets of fixtures selected by the customer. The accompanying illustration gives some idea of the pictures of the fixtures, as well as of the portfolio itself. The latter is bound in a fine grade of imitation leather and is very convenient to carry along and display. A well planned merchandising booklet instructing the dealer in methods of selling lighting fixtures completes the outfit. Dealers may obtain further information regarding this merchandising plan by writing Farm Light and Power.

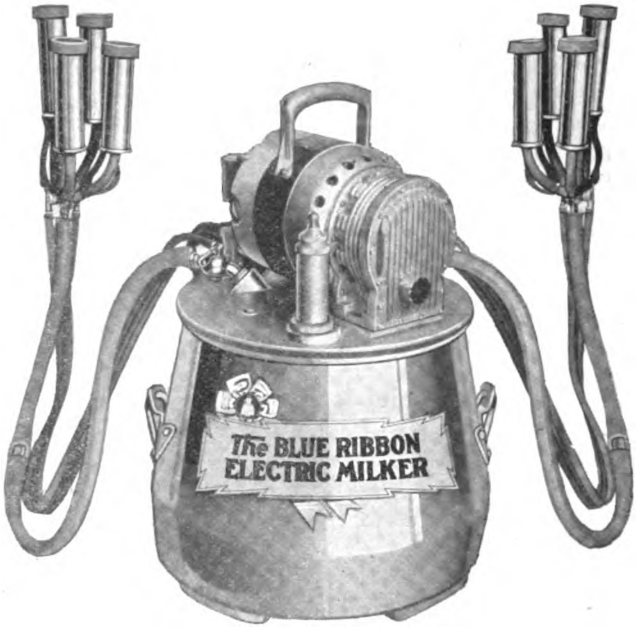
### Selling Milking Machines

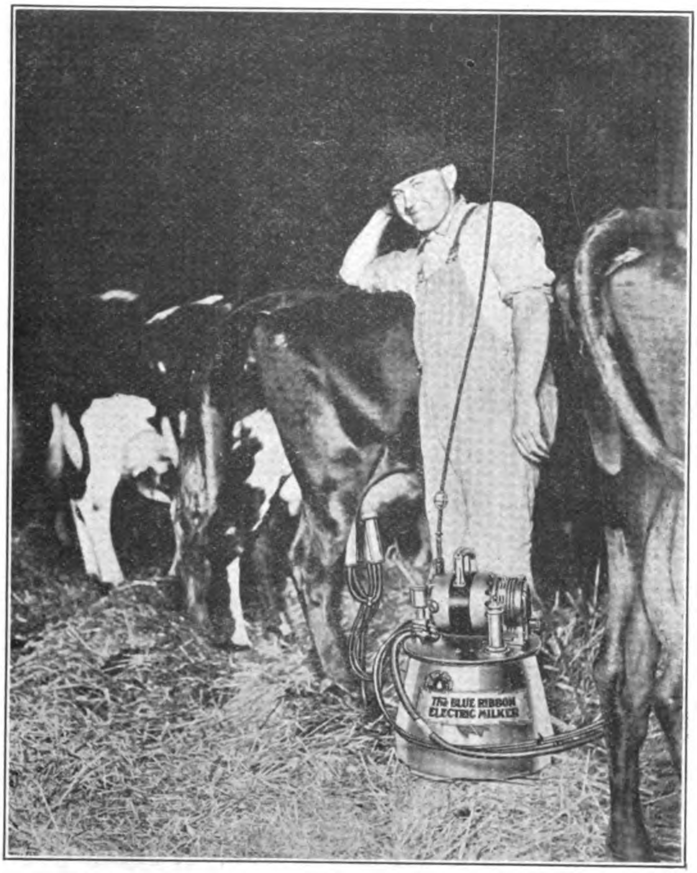
In the sale of the farm light and power plant and practically everything that goes with it, the dealer's strongest argument to every wide awake farmer should naturally be the question of labor and time saving. Even though he does not count in the cost of his own time in figuring anything, as is very common with farmers, he is very much on the alert when you



Reidon fixture portfolio exhibit and two of the sheets

A portable type milking machine that pays for itself in time and labor saved even where very few cows are kept




Perfection milker shown in operation

Electricity has done more to take the drudgery out of farm life than all other things combined. What the washing machine does for the farmer's wife, the milking machine does for the farmer or his boys and girls. With a milking machine "chores" no longer make it necessary to get up two hours before breakfast. Even though you are not in a dairy section you can sell milking machines

figure up the cost of a man's wages. In many cases it will be easy to demonstrate that the use of a milking machine will save one man's wages the year round and in this way pay for itself several times over in the first year of its use. It will naturally be found much easier to sell the portable type, self-contained milking machine now being marketed than it has been to sell the larger outfit which required a separate engine or large electric motor to run the vacuum pump, since the number of farmers to which an outfit of this type could be sold was naturally more or less limited.

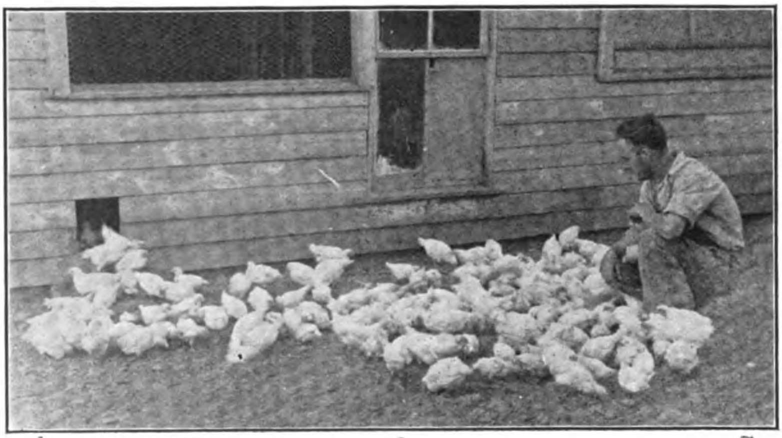
On the other hand, the portable, self-contained type of milking machine which has the motor on the cover of the pail itself can be sold to farmers having only a very few cows. It will pay on any number from two up.

Labor costs have not gone back to the standard maintained before the war. "Hired help" costs a good deal more now than it did seven or eight years ago and it appears to grow less efficient as the cost goes up. It is a very general complaint on the part of the farmer that help is continually costing him more and he is getting less for the outlay. This is just what makes possible the sale on a large scale of so many electrically driven labor-saving devices. The farmer who says he can't afford to buy a light and power plant, a water system, a washing machine for his wife, or a milking machine, is really paying for all of them several times over in the extra cost of his labor. He is paying for them without having the benefit of their comfort and convenience.

Supplementing these arguments with an actual demonstration of the machines themselves will make the sale just as it does in the case of the plant or the washing machine or anything else on your long list of appliances and accessories.

### Accessories and Appliances in General

What has been said in the foregoing pages regarding the sale of some of the major accessories such as washing machines, water systems, milking machines and the like, applies equally well to the entire range of accessories and appliances in general that the dealer will find it profitable to handle. In the case of small items such as electric irons, he will find it an advantage to carry samples with him and to keep a stock on hand. This, of course, also applies to wiring supplies, fittings and the like. He should have a sufficient supply of these on hand to take care of his ordinary requirements since nothing dulls the edge of sales quite so much as having to wait too long for deliveries.



**These birds produce most money in winter with electric light. Poultry keeping represents two sources of income for the dealer. It makes a good prospect for a plant and, after the sale, for many accessories such as time switches and supplies**

# Electric Poultry Devices

THE application of electricity to any device improves it to the same degree that electric light is an improvement over smoky kerosene oil lamps. This is particularly true of the application of electric heat to incubating and brooding. By referring to the text on the elementary principles of electricity, it will be seen that electricity is converted into heat by the resistance of the conductor through which it passes. By making the conductor of a specially high resistance metal, as much heat as may be desired can be generated by a comparatively small amount of resistance wire, or a heating element, as it is commonly called. Being in the form of wire, it has the great advantage of permitting the heat to be distributed to all corners of an incubator or brooder, since the small coils of wire can be distributed in such a manner so that the heat will be applied as needed.

Electric incubators and brooders are all based on this principle. They contain what is known as a heating element, usually composed of coils, whether in round or flat spiral form, on an asbestos or other noncombustible foundation so that there is no danger whatever of fire. The thermostat, or heat regulator, is of the usual type, but since electrical heat may be controlled within such close limits, the heat regulator is more sensitive than those of ordinary incubators. In electric incubators and brooders, these heat regulators will operate on such slight changes of temperature that, unless the incubator doors are opened, there is apparently no variation whatever in the temperature. They will hold the heat so steadily at whatever point they are set for, as 103°, that anyone not familiar with the operation of electrical incubators will begin to doubt the thermometer after a week or two, since it shows no variation from the 103° line. Being so sensitive in action, they will also respond very much more promptly to any sudden changes of outside temperature, thus maintaining such a uniform condition in the incubator that hatches are increased proportionately. A small electric light is usually placed in the incubator and either comes on automatically when the door is opened or may be turned on with a button. Electrical incubators have shown so many advantages over old types that many of the

Oakes

Lectro-Hatch

Electric incubators and brooders of different makes

Lo-Glo

very large poultry plants having a capacity of ten to twenty thousand eggs at a time have installed all electrical eqquipment. The brooder is equally simple to handle.

### Poultry Lighting and Egg Production

Both the foregoing brief descriptions of the electric incubator and brooder and the following matter concerning the use of electric light in connection with automatic time switches, to extend the daylight day for laying hens, is given here chiefly to impress upon the dealer the sales opportunities that these devices represent as a means of increasing his annual profits. In the limited space available, it is naturally impossible to go into any one branch of the subject to any considerable length, but the information given here should be more than sufficient to awaken the dealer to his opportunities to sell electric incubators and brooders, electric units or heating elements for old incubators, time switches, wiring and supplies for poultry houses.

The increase in egg production with electric lighting in winter, is naturally due to reproducing artificially the equivalent of the summer daylight day. The hen is given an opportunity to feed and exercise over the same number of hours as during the long spring and summer days. Naturally there is a great deal more to be learned about it than can be given in this limited space. Some big poultry raisers have found that it pays them very well to install the equipment necessary to turn on the lights dim at first, then after a period of an hour or so to full brilliancy and then at the end of the feeding period to reverse the process, dimming them and then putting them out, instead of cutting the light off altogether suddenly. There is more or less difference of opinion as to whether the day should be extended by lighting in the evening, or by lighting in the early morning hours. Both

Lectro-Hatch

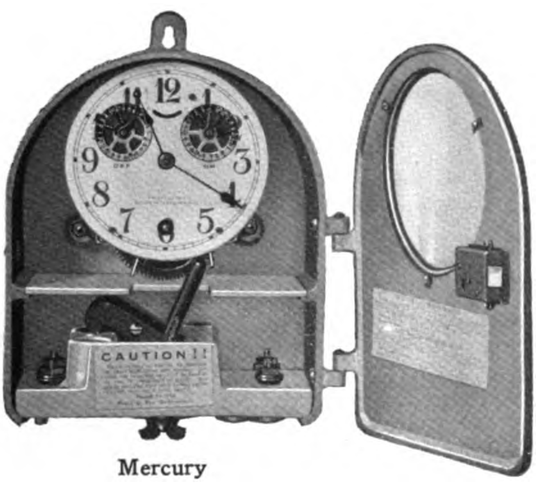
**Electric incubator of a type that is being largely adopted by commercial hatchers as well as small users. Don't let another season go by without adding electric poultry specialties to your income-producers**

have proved successful in many cases. The one point on which all are agreed is that the profits are all out of proportion to the outlay required, so that the advocates of all of the many ways of increasing egg production when egg prices are highest, are satisfied they are getting their full money's worth. It will pay you as a dealer to study up this subject by reading the experiences of some of the successful users in the different poultry journals and bulletins of the agricultural experiment stations. If you are a poultry raiser yourself, even on a small scale, rig up your own poultry house and you will have a good demonstrator.

### Automatic or Time Switches

The electrical device that has made this practice of increasing winter egg production successful, is the automatic, or time, switch, of which illus-

trations of two or three different types are shown accompanying the text. As its name indicates, the automatic switch is simply a combination of a clock and a switch. This is timed to control one or any number of circuits, on or off, any number of times a day, the clock mechanism usually being of the eight day type.



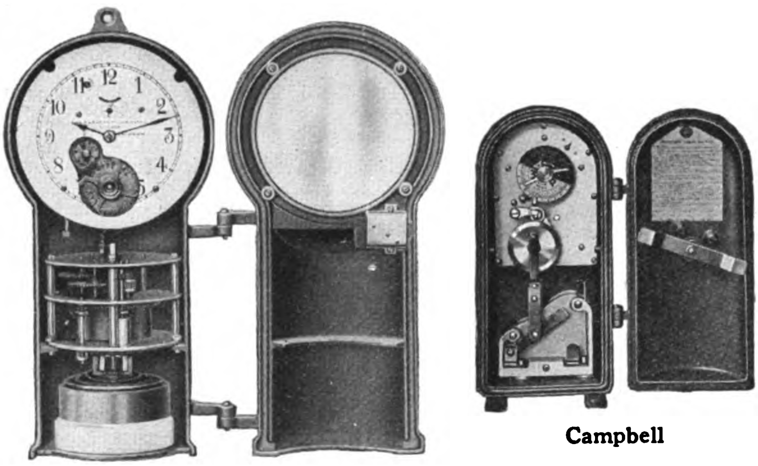

Mercury

**Types of time switches that are being very successfully used by poultry raisers. You can sell them for other purposes as well, besides using them to advantage in your own business**


Campbell

It doesn't require an expensive time switch to control the circuits necessary in poultry lighting. Where the day is lengthened by getting the hens off the roost earlier in the morning, a one-circuit time switch may be used to light the poultry house at three or four A. M. and to turn the lights off again at 7:30 or 8:00 o'clock. The next step in advance of this would be a time switch that puts the lights on again at first for half an hour and then turns them on full, to reproduce the gradual increase in natural lighting with the rising of the sun. This is done, where a storage battery is used, by connecting one of the circuits up to half or two-thirds of the cells so that the lights will only burn dimly. When the clock turns the switch to the next point, this sends current from all of the cells through the lamps and they burn at full brilliancy. In the case of 110-volt service, a small resistance unit can be connected in the first circuit with the lamps. For those who find it preferable to extend the day by lighting in the evening, the switch can be set to turn the lights on full at about 4:30, or before it is actually dark. They are then kept on full until about 8:00 P. M., then dimmed for half an hour, after which they are shut off.

There are a great many other uses for the time switch besides poultry house lighting and it will pay every live dealer to put time switches down on his list of appliances that he counts on being profit-makers. In and around cities, time switches are largely used for turning off the lights in



Campbell

Campbell

Paragon You can sell these time switches for many purposes

display store windows at the end of the evening, say 10:30 or 11:00 o'clock. Also for lighting advertising billboards, signs and similar uses. Connect one up with your own demonstrating plant or store display and it will be much easier to explain their good points to your customers.

## A Common Experience

We have lights throught incubator, cellar and laying houses. In one laying house we have 6 75 watt nitro bulbs arranged to light automaticallv at 3 A. M. In this house there are 650 S. C. white leghorn pullets. From November 1 to 12 they ran 133 to 200 eggs per day. On the 12th our electric service failed and the central power station gave us no current for a week. By the 21st our average had gone down to 125 and it took two weeks to get them back to where they were when the lights went off. Without the lights I doubt if we could have averaged better than 100 eggs a day so that the increased egg yield will pay for the investment in one winter.

**The foregoing is but one of many similar experiences constantly being reported to the Editor of Farm Light and Power**

## Standard Weights and Measures

Troy Weight—24 grains=1 pwt.; 20 pwts.=1 ounce; 12 ounces=1 pound. Used for weighing gold, silver and jewels.

Apothecaries' Weight—20 grains=1 scruple; 3 scruples=1 dram; 8 drams=1 ounce; 12 ounces=1 pound. The ounce and pound in this are the same as in Troy weight.

Avoirdupois Weight—27 11-32 grains=1 dram; 16 drams=1 ounce; 16 ounces=1 pound; 25 pounds=1 quarter; 4 quarters=1 cwt.; 2,000 lbs. =1 short ton; 2,240 lbs.=1 long ton.

Dry Measure—2 pints=1 quart; 8 quarts=1 peck; 4 pecks=1 bushel; 36 bushels=1 chaldron.

Liquid Measure—4 gills=1 pint; 2 pints=1 quart; 4 quarts=1 gallon; 31½ gallons=1 barrel; 2 barrels=1 hogshead.

Time Measure—60 seconds=1 minute; 60 minutes=1 hour; 24 hours=1 day; 7 days=1 week; 28, 29, 30 or 31 days=1 calendar month (30 days=1 month in computing interest); 365 days=1 year; 366 days=1 leap year.

Circular Measure—60 seconds=1 minute; 60 minutes=1 degree; 30 degrees=1 sign; 90 degrees=1 quadrant; 4 quadrants=12 signs, or 360 degrees=1 circle.

Long Measure—12 inches=1 foot; 3 feet=1 yard; 5½ yards=1 rod; 40 rods=1 furlong; 8 furlongs=1 sta. mile; 3 miles=1 league.

Cloth Measure—2¼ inches=1 nail; 4 nails=1 quarter; 4 quarters=1 yard.

Mariners' Measure—6 feet=1 fathom; 120 fathoms=1 cable length; 7½ cable lengths=1 mile; 5,280 feet=1 stat. mile; 6,085 feet=1 naut. mile.

Miscellaneous—3 inches=1 palm; 4 inches=1 hand; 6 inches=1 span; 18 inches=1 cubit; 21.8 inches=1 Bible cubit; 2½ feet=1 military pace.

Square Measure—144 sq. inches=1 sq. foot; 9 sq. feet=1 sq. yard; 30¼ sq. yards=1 sq. rod; 40 sq. rods=1 rood; 4 roods=1 acre; 640 acres =1 sq. mile.

# How Electric Lighting Increases Egg Production

EXPERIMENTS at New York State College of Agriculture prove electric lights in poultry houses increase total yearly egg production of the flock and make hens lay during fall and winter months when high priced eggs are the rule.

The black spaces in Chart I represent the night and the white spaces the daylight. Observe that on December 21st the night was approximately fifteen hours long and the day nine hours, and that on March 21st and September 21st the days and nights are equal. In Chart II (opposite page) the black spaces represent the time when there was no light, the white space the daylight plus the artificial light. Note that the lights were on from six in the morning until dawn and from twilight until nine o'clock throughout the year, reducing the darkness to nine hours and the lengthened day to at least fifteen hours.

### Electric lights on morning and evening

*The shaded portion in the center of the charts illustrates the percentage of egg production under normal conditions and also under the influence of electric lights.

Chart II shows how the flock was influenced to increase egg production during the months when the nights are longest. The plotted curve of produc-

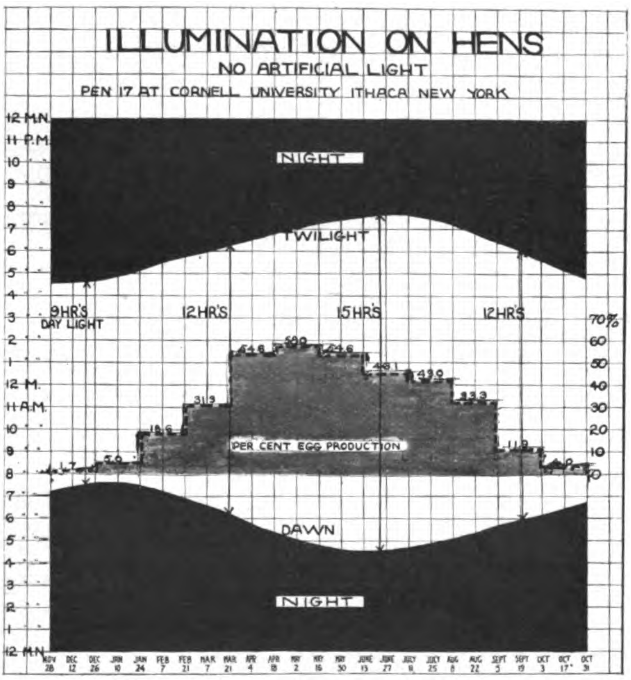



Chart I—No artificial lights used

**Striking illustration of how closely egg production is governed by the length of the daylight day. Hens aren't influenced by daylight saving laws but they do believe in eating and will eat as long as there's light. The more they eat the more eggs they produce**

tion in Chart I superimposed over the plotted curve of production in Chart II shows a remarkable gain in egg production during the months when fresh eggs are high and a slight falling off during the spring and summer months when eggs are at the lowest price. Note, also, there was an actual increase in production for this year.

*From the "Cornell Countryman," by permission of Professor Rice of Cornell University. Illustrations and text courtesy Western Electric Co. Publicity Dept.

### An Automatic Switch and Dimming Device

It is not necessary for the poultryman to turn on the lights himself each morning, nor is it necessary for him to be on hand at nine o'clock at night to dim the lights and turn them off himself. An automatic switch and dimming device can be made to do this work for you. It will be necessary to set and wind a clock, that is all. Egg production by electric lights will require no more attention than without the lights.

**During the short winter days it takes all a hen's time to get enough to eat to keep her warm. There's no surplus for egg production. See that your customer's poultry houses are lighted and provided with a time switch. One season's increased income will pay for the installation**

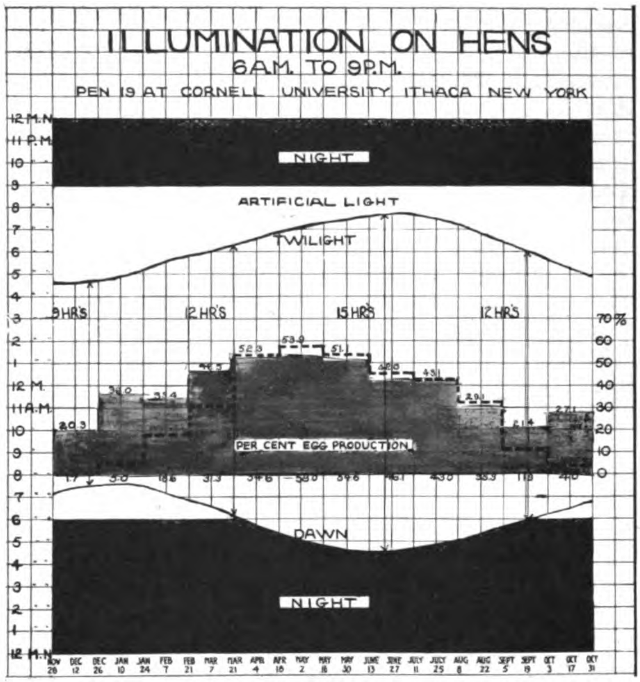



Chart II—Electric lights used

### Relative Weight of Materials

| Material | Specific Gravity | Lbs. per Cu. Ft. | Lbs. per Cu. In. |
|---|---|---|---|
| Aluminum, Cast | 2.56 | 159.6 | .0924 |
| Aluminum, Sheet, rod or wire | 2.67 | 166.5 | .0963 |
| Antimony | 6.76 | 421.6 | .2439 |
| Bismuth | 9.82 | 612.4 | .3544 |
| Brass, cast (70% Cu.) | 8.4 | 523.8 | .3031 |
| Bronze (90% Cu.) | 8.85 | 552. | .3195 |
| Copper, sheet or wire | 8.93 | 556.8 | .3222 |
| Iron, cast | 7.218 | 450. | .2604 |
| Iron, wrought | 7.70 | 480. | .2779 |
| Lead, cast | 11.38 | 709.7 | .4106 |
| Mercury (60°) | 13.58 | 846.8 | .4900 |
| Platinum | 21.50 | 1342.13 | .7767 |
| Silver (Standard) | 10.312 | 644. | .3710 |
| Steel, Bessemer | 7.854 | 489.6 | .2834 |
| Tin, pure | 7.29 | 455.1 | .2634 |
| Zinc | 7.0 | 436.5 | .2526 |
| Glass | 2.62 | 163.4 | .0945 |

# Valuable Points on Electric Irons

SOME successful dealers who have been interviewed say that practically the first accessory they sell to their customers after the farm light and power plant has been installed is the electric iron. Of course, this is true particularly of the summer season when the electric iron means a great deal more in the way of comfort and convenience than it does in the winter. A wood fire in a kitchen range is almost unbearable from May to October so that sales of electric irons may be counted upon during the greater part of the year. The dealer is accordingly justified in laying in a fairly heavy stock of irons since he can usually be certain of selling several a week so that it pays to carry two or three with him every time he goes out on a trip. The investment is so small that he can also afford to place half a dozen or a dozen of them out on a make-good basis for a week or two at a time. The farm light and power dealer is really in a very much better position to sell accessories like electric irons than the electric dealer and contractor in cities and towns who must dispose of them over the counter.

Electric irons are an important factor in making plant sales as the dealer can have no better argument with the prospect's wife than that, with a farm light and power plant of sufficient size, she can use an electric iron. But the dealer should learn all he can about electric irons in order that he may choose the iron which will give the greatest satisfaction to his customers and make the fewest calls on him for service.

The dealer must see that the plant is big enough before recommending an iron. An electric iron cannot operate on less than 500 watts, and this is the rating of an iron when in use. When the iron is first connected, the current consumption is greater, since the resistance increases with the rise in temperature (see Electric Principles). A comparison of ten leading irons shows that irons rated at 550 watts will draw as much as 680 watts cold. The actual watt consumption per hour will depend on the construction of the iron, some irons requiring an almost continuous consumption while others can be disconnected for a longer period, ironing with the heat stored up in the iron. This varies with the material in the body of the iron, one iron that has a soapstone body giving a remarkable performance in this respect.

### Educate Them in Using the Iron

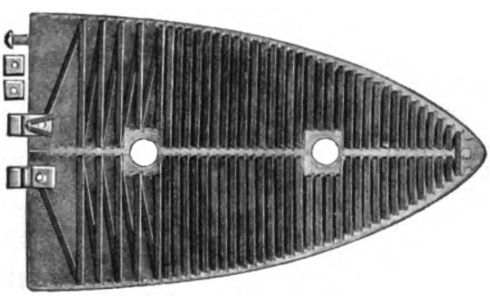
In some instances, it may prove too easy to sell an electric iron. You know the size of the battery of every plant owned by your customers or by the customers of your competitors as well. Don't be too ready to sell an electric iron to a customer who has too small a battery to carry it successfully. It isn't a good thing to sell irons indiscriminately to your customers, without giving them a word of caution as to how the iron should be used. There is one thing you can make up your mind to and that is that all your customers are going to buy electric irons whether you sell them or not, so it is far better for you to sell them and do the job right while you are about it as otherwise they will buy electric irons elsewhere and probably cause you a lot of trouble on the service end.

Explain carefully to your customers the heavy load that an electric iron represents and, as it is usually used for a large part of the day, the great amount of current that it will draw from the battery. Therefore, caution them particularly to run the plant during the day that the electric iron is used. Two ends will be served by this, since the electric iron will be put to satisfactory use all day without any injury to the battery. Instead, the latter will receive part of a charge as the current is not kept on the iron steadily all the time and any excess current while the iron is being used will go into the battery as well. In the case of customers who have very small plants, better caution them that the iron should never be used

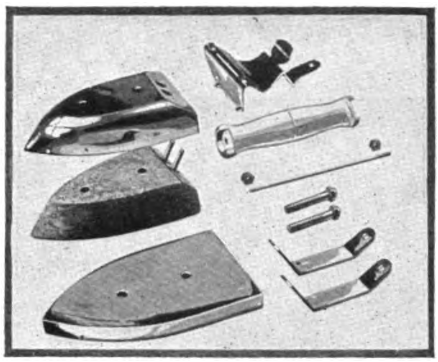
except when fed directly by the plant. That is, the battery should never be relied upon to supply current to the iron because if this is done, the lighting will not be satisfactory and there will be no power left for other appliances. It is about all that a 500 watt plant can be depended upon to do, to carry the iron alone.

### What the Electric Iron Is

The electric iron is a simple electrical heating device, based on Ohm's Law (see text on Electric Principles). The heat is produced by passing the current through a special high resistance wire, or grid, made of an alloy consisting of nickel and other metals. This resistance, termed the heating element, is embedded in a fireproof insulating compound so that the iron not only heats quickly but retains its heat for comparatively long periods. The accompanying illustrations show a number of different types of electric irons, also some of these irons before assembling, showing the different parts. The resistance, or heating element in all good irons is made of a nickel-chromium alloy. This will stand a very high temperature without burning out as it has a very high specific resistance and resists oxidation to a very great extent. The introduction of this alloy marked a new era in all electric heating devices.

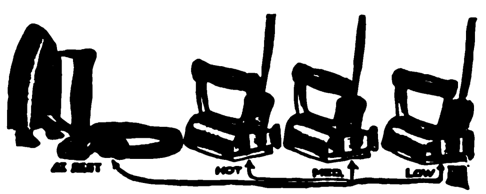


**Heating element of the "Universal" iron, showing reinforced terminals and ease with which element may be replaced**

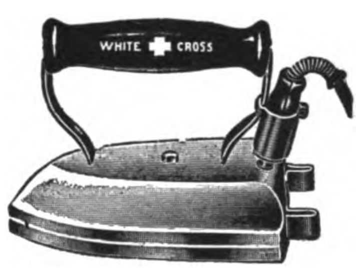


**Complete parts of the "Steatite" iron. In this iron the heating element is embedded in a heat-retaining stone insulator, economizing current**

The current consumption depends upon the size of the iron and the latter is governed by the purpose for which is intended. For example, a 5 pound iron consumes 450 watts, a 6 pound iron, 550 watts (nominal ratings). One company makes a 6 pound iron equipped with three heats, whereby the heat of the iron can be conveniently adjusted to conform with the ironing to be done, since the latter ranges all the way from light handkerchiefs to dampened sheets or pillow cases. The three heats referred to are especially applicable for a general purpose electric iron as the heat can be adjusted by switching the position of the plug in back of the iron to obtain the maxi-



**Waage electric iron with patent three-heat adjustment**

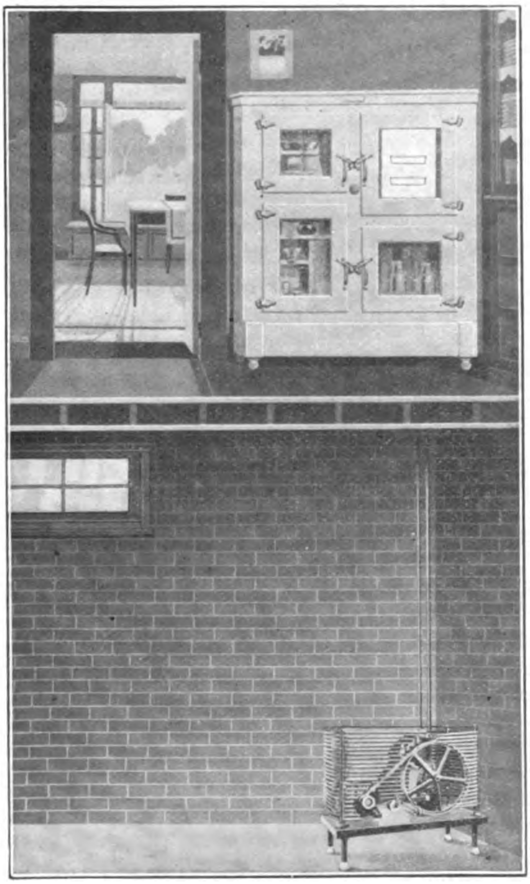



**White Cross electric iron**

mum heat needed for each purpose, using 550 watts for heavy wet ironing, 275 watts for medium work, or 137 watts for very light ironing.

Electric irons can give a good deal of trouble, and the dealer can be called upon to give more service on an iron than is justified by his profit. The dealer can guard against this by a careful consideration of the construction of the irons offered him. As a general proposition, the iron which is simply made, designed with comparatively few parts, will give less trouble and be more easily repaired than an iron with many small parts. Much iron trouble is trouble with the cord and with the terminals. Perfect contact must be provided between the cord connection and the iron and sufficient terminal surface to carry 21 amperes. The attachment plug should be preferably of the type with double contacts, and the cord should not be less than No. 14 B. & S. gauge.

The iron should have a heating unit replaceable by any non-mechanical person, so that your farmer customer or his wife could make repairs without calling on the dealer. There is nothing mysterious nor should there be anything particularly complicated about the design and construction of an electric iron, and the dealer who sells an electric iron should judge it exactly as he does any familiar mechanical appliance. It must be of sufficient size and weight, it should not take more than 550 watts (when hot) and every part must be strong, simple and of ample size.



**One convenient method of installing an ice-making and refrigerating machine having sufficient capacity for the average family's needs. A machine of this size can be run by a ¼ horsepower motor and is automatic in operation. This particular machine (Kelvinator) has an air-cooled condenser and so requires no plumbing connections**

**Typical Kelvinator installation with refrigerating machine in basement**

# Fire Prevention and Lightning Rods

THE farmer should give special attention to the elimination of fire hazards and the adoption of protective methods and the farm light and power plant dealer is in an excellent position to advise and help in the provision of the proper equipment. His house, barn and outbuildings are usually of combustible materials; being more or less isolated they are subject to lightning strokes; kerosene and gasoline are likely to be stored about the premises and used for light and power; he must fill his barn with hay, straw and feed which are subject to spontaneous combustion and he is usually outside of the protection of a fire department. Too often a fire once started in a farm building results in a total loss.

Among the most prolific causes of fires on farms are lightning, defective chimneys and flues, unprotected stoves and the careless handling of kerosene and gasoline.

The tabulation shows for the first time the detailed causes of fires on farms in one year, as reported to the Actuarial Bureau of the National Board of Fire Underwriters. These figures represent an analysis of 38,266 fires, with a total loss during the year of $18,166,701.

The statistics cover only the losses reported to the National Board and do not embrace the thousands of fires upon uninsured farms or those insured with mutual companies not reporting to this organization.

### Lightning the Chief Cause

As might be expected, the heaviest loss from known causes, $3,933,950, is due to lightning striking unrodded buildings, although experience indicates that a properly rodded structure is practically immune against a harmful visitation from this element.



*Text and illustrations courtesy National Board of Fire Underwriters*

Defective chimneys and flues hold second place as a cause of farm fires, with aggregate losses of $1,962,031, while sparks on roof stand third with $1,181,171.

Electricity figures as a comparatively unimportant cause, indicating that this hazard has not yet assumed serious proportions. Since these figures were compiled there has been rapid progress in the introduction of farm light and power plants and this development will be reflected in rural fire losses. Electric systems when properly installed according to the National Board's Electrical Code, are the safest known means of light and power; the hazard comes from amateur electricians and the carelessness of the users.

It has been mentioned that damage from lightning may be readily prevented. During one summer month, for example, there were 191 lightning fires reported in the Province of Ontario, but only two involved rodded buildings and it is probable that they were not properly equipped. A rod that is broken or that is not correctly installed actually increases the lightning hazard.

### Rod All Buildings

Not only should the house, barn, silo and all other structures be rodded, but wire fences should be "grounded." Horses and cattle frequently drift along with a storm until they come to some barrier. This is likely to be a wire fence which becomes charged with electricity under certain storm conditions. If the fence in the open field is well grounded at least every ten rods, and at every corner in yards, a lightning stroke will be carried harmlessly into the ground.

To quote from the "Suggestions of the National Board of Fire Underwriters for Protection Against Lightning," a copy of which may be had upon request:

"The ordinary condition causing a lightning discharge is a cloud charged with electricity at a greatly different potential from that of the earth. The difference of potential is finally sufficient to 'break down' the stratum of air between earth and cloud, and an electrical discharge takes place. The resistance of the air stratum being generally less between cloud and tops of buildings and other structures than between cloud and earth, such high points take the discharge, and unless some less resistive path is provided, the lightning will follow the next best course to earth, generally damaging the structure and frequently starting a fire.

"It is therefore desirable to locate the conductors forming the lightning

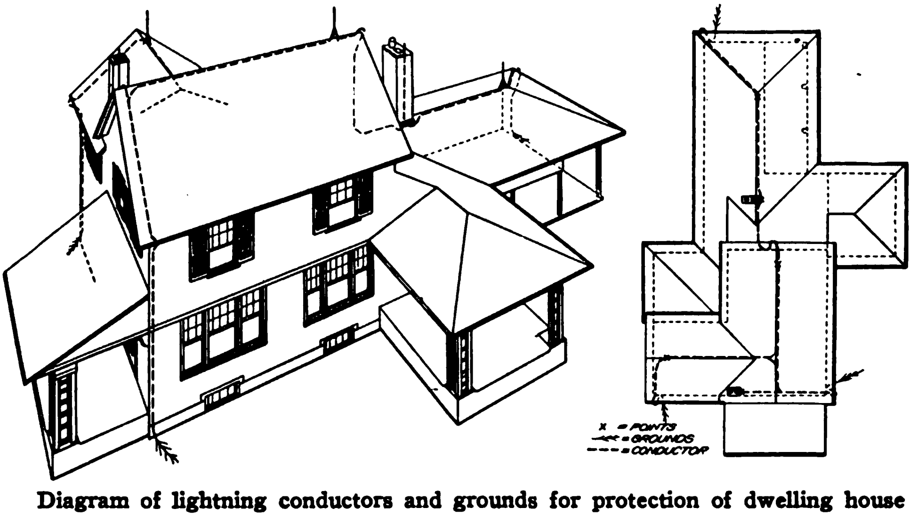



**Diagram of lightning conductors and grounds for protection of dwelling house**

protection so that the lightning will strike these and be carried to earth instead of tearing through the structure on its way to the ground.

"Where wire fences are grounded, a rod or cable equal to three number twelve wires, or one number nine, of the same material as the fence wires, should be used to connect up each lateral wire of the fence and it should extend at least three feet into the ground. If the ground wires are allowed to project a few inches above the fence they will prevent strokes in their vicinity in the same manner as points on a building.

"Where fences are connected with a building, they should be grounded at the first post from the structure and, in addition, the ground rod of the building should be connected with the fence. Silos should also be rodded."

### Nature of Lightning

The atmosphere and the earth's surface are electrified at all times; usually the atmosphere is positive and the earth's surface negative. During thunderstorms, however, the electrification in the atmosphere, that is, the separation of two kinds of electricity, is much increased, and the attraction of the two charges of opposite character or sign—usually positive electricity in the lower portions of the clouds and negative on the earth's surface, as also on the higher portions of the clouds—is also much increased. The electrical resistance of the intervening air may then be overcome and a discharge occur; which is a stroke or flash of lightning between cloud and earth, or between different parts of the cloud itself. A better concept of a lightning discharge may be obtained by comparing it with the familiar electric light current. The voltage of a lightning discharge may be several millions as compared with the customary 32- or 110-volt current; the amperes, or current strength, may be in excess of 20,000 compared with only one or two passing through a high-powered incandescent lamp. But the duration of a lightning discharge is very brief.

The presence of a system of lightning conductors on a building serves in a way to discharge the electricity silently during storms, and thus to decrease the intensity and number of strokes. But when the accumulation of atmospheric electricity is very rapid, the aerials and conductors on one building, or even on many buildings grouped together, may be entirely insufficient to prevent violent discharges. The points and conductors on buildings on such occasions serve to direct the stroke to the ground so that little or no damage occurs.

It is sometimes stated that lightning conductors are undesirable because they "draw lightning." That may be true to a slight extent. A violent stroke of lightning that otherwise would come near to a conductor on a building would very likely be diverted to it and pass to the ground harmlessly. On the other hand, if the building were unrodded, the stroke would probably cause damage; hence it is advisable to protect all buildings that are either valuable themselves or house valuable contents.

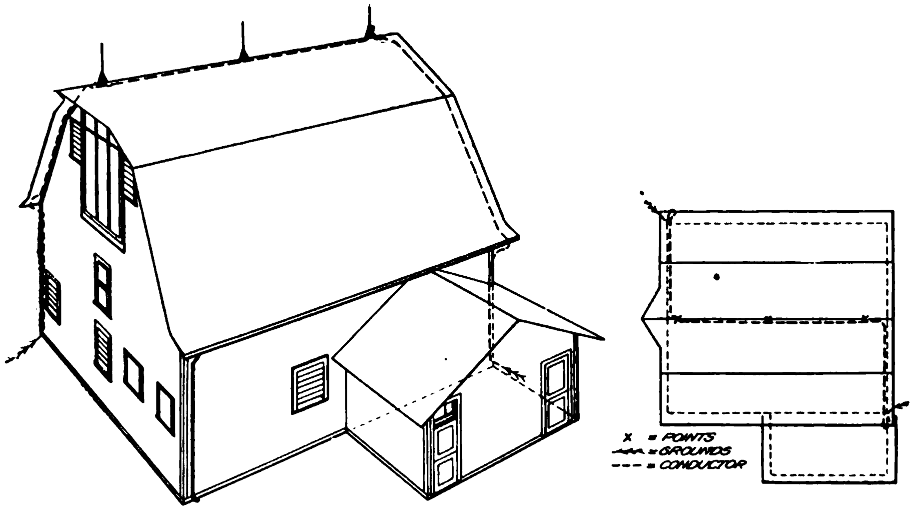


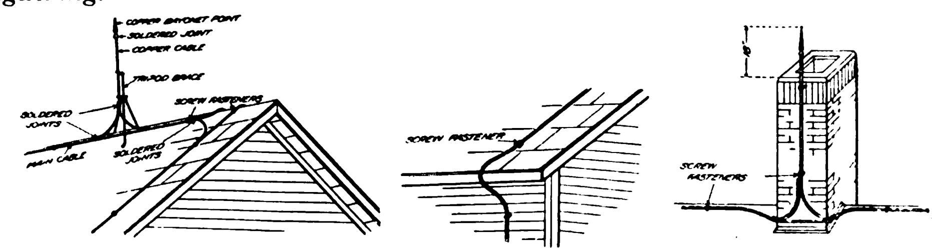

**Diagram of lightning conductors and grounds for protection of barn. Where there is a silo, it must be protected also**

There are several factors entering into a choice of the type of equipment, such as, value of the building, nature and value of contents, and whether protection of human or animal life is involved. In regions of frequent and violent thunderstorms, dwellings, barns, and other buildings representing a considerable investment, or housing valuable or inflammable material, should be rodded in as effective and durable a manner as possible.

### Do Lightning Rods Give Protection?

During the one hundred and sixty-seven years in which lightning rods have been experimented with and used they have proved their efficiency beyond a doubt. This has been strengthened and backed up by statistics and investigations of scientists, engineers, U. S. Department of Agriculture, insurance companies, and state fire marshals. The recommendations and reports and the statistics which have been gathered conclusively prove that a properly erected lightning rod system insures protection, although there was a time a few years ago when if a man mentioned lightning rods he was likely to become involved in a heated argument. This was due to the unscrupulous selling campaign of some irresponsible makers and dealers of lightning rods who knew little or nothing of proper installation and cared still less.

The unfortunate reputation gained in that period has made it hard to convince some people of the efficiency and protective value of a lightning rod. However, these conditions are changed. Several old and reliable companies who have always sold lightning rods for protection and not simply as a means of relieving the farmer of his money, have, with the aid of the National Board of Fire Underwriters and other sources, conclusively proven that lightning rods, properly erected, render 99 per cent. protection against lightning.



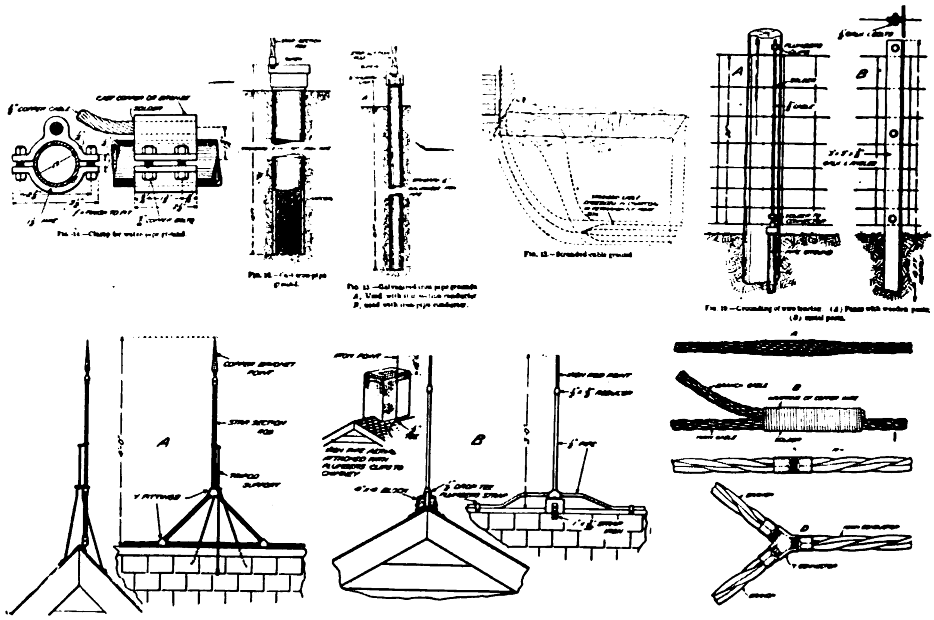

**How the lightning conductors are run on roofs and chimneys**

The Industrial Commission of Wisconsin reports that in that state lightning kills more people than the railroads of the country: that during 1920 there were 232 lightning fires on unprotected buildings in Wisconsin with a property loss of $958,925 and 14 such fires on poorly rodded buildings were in the amount of $64,185, but upon investigating the rodded buildings that had been struck by lightning it was found by the Commission that there were vital faults in the material used or in the installation or in both.

The more common defects in these 14 rodded buildings were materials of insufficient weight to carry off the stroke, insufficient number of points, lack of points at the chimneys and other elevations, running metal clothes lines from trees to buildings, constructing silos and other additions without extending the rodding system, the corroding and breaking off of the ground rods and the like.

The Industrial Commission further stated that these defects were due to using light or inferior material and attempting to save on points, connections and groundings. The Commission goes on to state that if the system is of good material properly installed, well-grounded, and put up by a competent man and kept in repair, it is certain protection and an inexpensive guarantee of safety of life and property.

The limited space available does not permit of giving detailed descriptions of the various materials used and the methods of installation. Each manufacturer has his own and will instruct his dealers how to install his particular equipment properly. The Underwriters' figures previously quoted show the enormous damage done by lightning to insured buildings in one year. The total lightning losses for five years in this country show an average of very close to ten million dollars a year. With the various illustrations which show some of the methods of installation and the accompanying text it is an easy matter for the dealer to see how simple this is and also to realize how important this field is to any electrical man, such as the farm light and power dealer.



**Details of grounds, fence protection, aerials and splices**

*If you want any information not to be found here, write us or any manufacturer, mentioning the Farm Light and Power Year Book*

# Some Valuable Pointers for the Dealer

TOO many farm light and power dealers have overlooked the close relationship between their line and lightning conductors.

This relationship is founded on two main features:

(1) A Common Market.

(2) Similarity of working principles,—qualifying the dealer in one line to understand the technicalities of the other to an unusual degree.

Referring to the common market feature, it is a well known economic fact that the dealer who is equipped to take advantage of the incidental demands of the market into which his main line takes him enjoys an opportunity to increase his profit with a minimum increase of overhead expense.

The farmer and the small-town resident both constitute the logical market for light and power plants and for lightning conductors. The dealer who installs a light and power plant for a customer is, therefore, brought into direct contact with a prospect for lightning conductors and has the advantage of being already on a "business contact" basis. This is a psychological fact of great importance and one that should never be overlooked, namely, the ease with which an existing deal can be extended into further negotiations as compared with the difficulty of establishing this "business contact" basis in the first place.

Furthermore, the dealer in both lines has the advantage of two entering wedges. A customer who is interested in a light and power plant becomes a prospect for lightning conductors and an inquiry on lightning conductors can later lead to negotiations for a plant. The installation of one line brings the dealer on to the premises of the customer on a legitimate footing where he is in a position to discuss the other line under more advantageous circumstances than is the case where his sole errand is to force a sale against the prospect's instinctive resistance.

The second feature is also of great importance. The public has come to recognize the fact that when it purchases a lightning conductor system it purchases protection—the system is merely the medium through which the protection is provided—and that protection is primarily dependent on correct installation. Correct installation cannot be secured if the dealer is ignorant of the elementary principles governing the workings of electricity.

A dealer who has successfully handled and installed light and power plants has necessarily inspired a certain amount of confidence in his technical knowledge and is, therefore, in a better position to explain the necessity of correct installation as a primary consideration, thus doing away with the old time haggling over the price, based on amount of footage only.

Another point to be kept in mind is that the dealer in lightning conductors is entitled to a profit commensurate with the skilled knowledge necessary to a successful conduct of the business and should base his price for protection on this consideration.

*Contributed by Security Lightning Rod Co.*

## To Help the cause of Fire Prevention is the duty of every dealer as an American Citizen.

**As a business man, it is to your interest to help reduce our criminal fire loss of almost a million dollars every twenty-four hours. Fifty thousand dollars worth of farm property goes up in smoke every day. Lightning and easily extinguished small fires (at the start) are responsible for most of it.**

## Importance of Fire Prevention

IT may strike the farm and light power dealer that fire prevention is no particular concern of his. If one of his customers is so careless as to let his building catch fire and burn up, why that is his loss and not the dealer's. Is it? Every plant that the dealer sells means an added customer for all kinds of electrical appliances and accessories, in fact, a customer for everything that the dealer handles. Once he has secured the owner's confidence in his ability to sell him the right thing in a farm light and power plant and keep it in satisfactory running condition, the owner will take the dealer's word for anything the latter wishes to recommend.

Within a period of five years from the time he sells the plant, the dealer can count on the sale of several thousand dollars' worth of accessories and appliances to its owner. If the owner's buildings burn down in the meantime with only a small part of the loss covered by insurance, that owner is not going to be in a position to buy anything from the dealer. Hence, apart from the fact that every loyal American citizen should be vitally interested in fire prevention as a means of cutting down the tremendous annual losses suffered in this country from that cause, the dealer has a direct personal interest in seeing that none of his customers' buildings are burned. The farm light and power plant he has installed is quite as likely as not to burn with them and when it does his chances of further sales in the immediate future are wiped out with the plant.

It is accordingly to your interest as a wide-awake dealer to help prevent the loss of any of your customers' buildings as well as of those whom you expect to make customers in the near future. In so doing you are not only protecting your own interests but you can make a substantial addition

to your profits by the sale of approved fire prevention equipment, while your customers will benefit in two distinct ways.

First, having at hand the proper means for putting out small fires at the start will prevent the loss of many a valuable building, not to mention live stock or the lives of some of his own family.

Second, it will enable him to obtain a reduction in his insurance premium because most of the progressive companies allow a rebate of 10 to 15 per cent. where equipment to take care of fire at the start is provided. This will enable your customer to increase his insurance so that his property is more fully covered. Fires are sometimes unavoidable, such as when caused by lightning, and the majority of the cases comprising the ten million dollar annual loss from this cause shows that insufficient insurance is usually carried. You are doing your customer a good turn when you recommend that he put in fire extinguishers and also that he carry sufficient insurance, including the value of the contents of buildings as well as the buildings themselves, since at certain seasons of the year the live stock and crops in a large barn are equal in value to the barn itself.

### Every Fire Starts Very Small

At the start, every fire is a pretty small affair. If means are at hand for putting them out effectively, ninety-nine out of every hundred fires could be stopped in the first five minutes but the first five minutes are what count most and unless an effective fire extinguisher is right at hand, even a very small blaze soon gets beyond the ability of several men to beat it out or extinguish it with buckets of water, whereas one man with a good fire extinguisher could put the whole blaze out in thirty seconds. In cities where ample fire fighting facilities are at hand much of the property may be saved even where the fire gets beyond the first five minute peried, since the firemen can bring to bear powerful streams of water within a very short time after the alarm is sent in. But in the country, any fire that gets beyond the start, means the total loss of the building and the contents. In the case of barns, it doesn't have to go five minutes because the contents are so highly inflammable that the first minute or two will increase the fire to a point where it means destruction of a building and contents.

### Types of Hand Fire Extinguishers

Time has shown that the only way to fight fire effectively is to cover the blaze with a blanket of gas which shuts off all access of oxygen to the

**Types of fire extinguishers that should be in every farm house and barn. They'll save their cost many times over in putting out one fire.**

*Courtesy O. J. Childs Co. and Fire and Water Engineering*

fire. When this occurs the blaze immediately dies out entirely, because without oxygen nothing can burn. This is the principle on which the modern hand fire extinguisher operates. These small extinguishers are brass cylinders containing a quart (in the smallest size) of tetrachloride of carbon and a hand pump, by means of which it can be sprayed upon the fire. This is an inexpensive material, the very small quantity of which creates a large volume of gas the moment in comes into contact with the fire, and it is the only effective means of fighting gasoline, grease and electrical fires, since water, or any solution containing water, will only spread a fire of the two former kinds and make it more dangerous in addition to damaging electrical apparatus.

The accompanying illustrations show the prominent types of the hand fire extinguishers used, the chief difference between them consisting in the type of pump. In the Fyr Fyter extinguisher, for example, a small brass air pump is used. This puts air pressure on the contents of the extinguisher so that the chemical is ejected in a constant stream which will reach a con-

## Causes of 38,266 Farm Fires in One Year

| Strictly Preventable Causes | | | | | | Partly Preventable Causes | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Defective Chimneys and Flues | Hot Ashes and Coals, Open Fires | Matches—Smoking | Open Lights | Sparks on Roofs | Exposure (Including Conflagrations) | Lightning | Sparks from Combustion | Spontaneous Combustion | Totals | |
| $25,076 | $3,018 | $5,590 | ...... | $18,908 | $842 | $15,374 | $30 | $674 | $125,479 | Ala. |
| ........ | 330 | 1,211 | ..... | 1,571 | ........ | 10,552 | ...... | 6,091 | 68,893 | Ariz. |
| 23,635 | 2,389 | 3,535 | 1,312 | 8,180 | 3,406 | 3,987 | 3,118 | 15,380 | 144,496 | Ark. |
| 91,819 | 35,165 | 89,725 | 1,897 | 41,310 | 45,431 | 17,608 | 13,309 | 39,817 | 837,035 | Cal. |
| 14,806 | 2,851 | 18,979 | 1,878 | 7,186 | 1,923 | 62,737 | 5,518 | 7,435 | 171,297 | Colo. |
| 645 | 2,605 | 374 | 30 | 44 | 4,496 | 13,817 | ...... | ...... | 71,068 | Conn. |
| 1,254 | ...... | 1,191 | 25 | ........ | ........ | 11,467 | 815 | ...... | 26,998 | Del. |
| ........ | ...... | ........ | ..... | ........ | ........ | ........ | ...... | ...... | 50 | D. of C. |
| 9,479 | 53 | 10,605 | ..... | 5,573 | 6,800 | 348 | 2,391 | 1,440 | 51,531 | Fla. |
| 5,618 | 18,195 | 23,191 | 348 | 48,242 | 12,040 | 26,653 | 939 | 7,925 | 258,492 | Ga. |
| 21,503 | 3,314 | 6,457 | ..... | 32,330 | 350 | 2,042 | 2,962 | ...... | 132,152 | Ida. |
| 200,270 | 3,686 | 74,290 | 6,629 | 135,534 | 52,178 | 604,146 | 13,874 | 83,854 | 1,806,172 | Ill. |
| 138,984 | 2,489 | 30,804 | 1,440 | 123,443 | 19,475 | 248,803 | 9,606 | 27,600 | 791,989 | Ind. |
| 134,305 | 10,921 | 42,016 | 2,105 | 75,547 | 32,232 | 453,686 | 14,833 | 44,384 | 1,175,810 | Iowa |
| 69,556 | 972 | 26,756 | 127 | 28,494 | 18,805 | 215,196 | 3,910 | 27,820 | 643,957 | Kas. |
| 57,214 | 13,607 | 35,658 | 666 | 53,676 | 14,090 | 109,067 | 1,598 | 18,031 | 579,556 | Ky. |
| 3,875 | 1,545 | 9,187 | ..... | 28,557 | 292 | 5,216 | 79 | 1,366 | 91,167 | La. |
| 28,328 | 264 | 19,230 | 44 | 4,309 | 10,854 | 15,800 | 4,355 | ...... | 172,446 | Me. |
| 21,816 | 32 | 77,150 | 849 | 15,459 | 13,536 | 64,222 | 6,450 | 15,546 | 351,303 | Md. |
| 64,074 | 4,484 | 31,760 | 15,341 | 34,984 | 17,104 | 66,144 | 7,958 | 15,067 | 493,658 | Mass. |
| 34,618 | 10 | 13,165 | 1,812 | 36,936 | 8,979 | 24,882 | 11,648 | 13,277 | 214,530 | Mich. |
| 18,516 | 1,616 | 6,879 | 6,316 | 10,688 | 580,299 | 39,402 | 12,249 | 1,100 | 770,495 | Minn. |
| 32,448 | 14,710 | 38,282 | 40 | 27,619 | 7,991 | 4,570 | 5,133 | ...... | 190,627 | Miss. |
| 77,727 | 1,191 | 31,703 | 1,962 | 50,280 | 27,420 | 190,887 | 7,157 | 28,507 | 592,725 | Mo. |
| 33,696 | 2,997 | 13,335 | 1,820 | 5,905 | 3,267 | 19,888 | 15,857 | 600 | 354,106 | Mont. |
| 28,579 | 2,508 | 14,875 | 100 | 9,673 | 1,692 | 220,725 | 1,351 | 26,894 | 426,782 | Neb. |
| 2,865 | 57 | 3,707 | ..... | 72 | ........ | ........ | ...... | 600 | 14,188 | Nev. |
| 50,830 | 235 | 1,226 | 7,213 | 1,046 | 7,600 | 53,402 | 4,650 | 550 | 181,379 | N. H. |
| 24,275 | 95 | 52,267 | 767 | 5,219 | 1,864 | 49,301 | 2,223 | 7,052 | 374,579 | N. J. |
| 2,727 | 285 | 1,999 | ..... | ........ | ........ | 843 | 80 | ...... | 16,979 | N. Mex. |
| 182,645 | 3,202 | 120,759 | 155 | 41,257 | 39,722 | 322,035 | 18,996 | 77,249 | 1,429,462 | N. Y. |
| 9,982 | 3,536 | 5,215 | ..... | 16,093 | 1,160 | 5,050 | 1,765 | 2,473 | 85,499 | No. Car. |
| 28,689 | 1,215 | 22,740 | 363 | 4,343 | 2,257 | 60,752 | 4,833 | 4,265 | 251,888 | No. Dak. |
| 140,073 | 4,263 | 27,553 | 2,001 | 76,842 | 28,247 | 336,957 | 22,465 | 52,010 | 1,084,960 | Ohio |
| 26,703 | 1,591 | 42,326 | 4,471 | 8,001 | 21,626 | 96,728 | 4,193 | 9,328 | 414,783 | Okla. |
| 31,412 | 1,888 | 4,491 | 99 | 27,966 | 15,029 | 1,317 | 50 | 10,116 | 143,717 | Ore. |
| 41,609 | 2,123 | 38,850 | 764 | 26,019 | 15,947 | 128,866 | 13,390 | 97,192 | 592,708 | Pa. |
| 22,588 | ...... | ........ | 78 | 6 | ........ | 3,353 | 20 | 400 | 834,381 | R. I. |
| 2,678 | 2,993 | 5,779 | ..... | 30,171 | 24,812 | 7,182 | 7,655 | 25,317 | 159,074 | So. Car. |
| 18,504 | 1,059 | 23,740 | 30 | 3,220 | 9,355 | 132,812 | 2,810 | 5,280 | 324,494 | So. Dak. |
| 38,986 | 9,011 | 28,096 | 1,024 | 43,867 | 12,869 | 76,287 | 3,210 | 9,050 | 400,012 | Tenn. |
| 52,995 | 9,668 | 11,837 | 190 | 16,706 | 4,701 | 6,258 | 6,148 | 4,995 | 289,004 | Tex. |
| 1,079 | ...... | 14 | ..... | 291 | ........ | 100 | 52 | ...... | 10,207 | Utah |
| 1,925 | ...... | ........ | ..... | ........ | ........ | 973 | ...... | 200 | 4,370 | Vt. |
| 45,255 | 7,004 | 16,623 | 10,440 | 22,461 | 4,912 | 96,135 | 192 | 15,153 | 368,225 | Va. |
| 48,911 | 705 | 22,851 | 10,015 | 34,018 | 15,291 | 4,282 | 6,538 | 1,001 | 263,088 | Wash. |
| 18,789 | 10 | 1,075 | 25 | 1,344 | ........ | 28,993 | 1,208 | ...... | 101,364 | W. Va. |
| 25,050 | 476 | 8,726 | 6,100 | 17,010 | 11,887 | 71,889 | 6,316 | 10,022 | 254,822 | Wis. |
| 5,620 | 1,200 | 5,168 | 55 | 771 | ........ | 3,216 | ...... | ...... | 24,677 | Wyo. |
| $1,962,031 | $179,568 | $1,071,987 | $88,531 | $1,181,171 | $1,111,381 | $3,933,950 | $251,934 | $715,151 | $18,166,701 | U. S. A. |

Owing to lack of space, the complete table showing all of the causes and the losses, are not given here, but in both the Strictly Preventable and Partly Preventable classifications, it will be noted that thousands of the fires must have been such, due to their cause of origin, that they could have been put out while small had a good fire extinguisher been at hand. For example, those due to Defective Flues, Smoking, Open Lights and Sparks on Roofs, show total losses of $4,215,189 in one year. A large part of this could have been saved by the expenditure of a few thousand dollars for fire extinguishers of the two types described.

Of all the classifications, Lightning is the greatest known cause of damage to farm property, totalling close to $4,000,000 in a year.

siderable distance and may be aimed accurately. This operates on exactly the same principle as the domestic water systems in which air pressure elevates the water supply.

In the Pyrene type of fire extinguisher, the brass pump acts directly on the liquid, the user operating the pump to throw a stream of the chemical on the blaze. Fire extinguishers of these types have to be approved by the Underwriters' Laboratories before they can be generally used and in thousands of instances they have proved themselves highly efficient in putting out blazes that had already gotten far beyond the ability of a man to stop even with a hose and water supply such as would be found on the average farm.

### Acid-Soda Type Fire Extinguishers

This is a larger type of hand fire extinguisher which has been in very general use for more than a quarter of a century, and has proven very effective in putting out ordinary fires at the start. It consists of a brass tank with a capacity of about two gallons, in the smallest size, and is filled with a strong solution of water and bicarbonate of soda. Inside the tank at the top is placed a bottle containing about half a pint or a pint of strong sulphuric acid. To operate the extinguisher it must be inverted, thus discharging the sulphuric acid into the soda solution and creating a heavy volume of carbonic acid gas when this liquid reaches the fire. It is not as effective on gasoline, oils, grease, or electrical fires as the type previously described, nor can it be as easily handled directly by woman or boy as the smaller extinguisher. While the charge is inexpensive, the Underwriters require that it be renewed every six months in order to assure the effective operation of the extinguisher when needed. This is a very effective type of extinguisher and has a good deal of good work to its credit, so that in many locations it may be preferable to supplement the smaller chemical hand extinguishers with one or two of these larger types.

### Recommend the Water System as Well

At the start the great majority of all fires are ordinary fires. That is, they start very small, first in a pile of trash, rags, or other inflammable material, and from this part of the woodwork of the building is set fire. At the outset while still very small they can be put out quite as readily with water as anything else provided the facilities are right at hand.

This is a strong sales argument that you can give your prospect for the installation of a domestic water system in addition to all the advantages that go with the supply of hot and cold water that can be drawn from the tap, instead of having to be carried from the well. Several instances have been recorded in *Farm Light and Power* during the past year where a domestic water system has enabled the farmer to put out what threatened to be a serious fire simply by means of his water system and a provision of a few special outlets with garden hose and nozzle attached. The stream of water from a garden hose with only 30 or 40 lb. pressure behind it is a very puny thing but so is the fire at the start and the small stream of water will suffice to put it out.

The foregoing are mighty good reasons why you as a dealer should be vitally interested in fire prevention. You can help your customer and in so doing help yourself. Anything you can do to prevent the loss of his buildings and property is keeping him as a customer for you. You can add a profitable line on which sales are easy to make because the buyer will get his money back the first year or so in reduced insurance premiums. You can also use your interest in fire prevention to help sell domestic water systems or extra equipment bought for them after you have already sold the customer a set.

You have a very strong argument to convince your customers in the fact that the National Board of Underwriters reports that the annual losses of farm property every year in this country are close to twenty million dollars (1918 report). Two-thirds of these result from common, everyday causes and nine out of ten of the fires could be put out at the start if the equipment for doing so was at hand. The other third are caused by lightning and most of these could also be prevented by the installation of proper lightning rod equipment as described in another section under that head. It will pay you as a dealer to recommend the use of fire extinguishers, approved lightning rod equipment, and ample insurance to cover all losses, because in doing so you will be preventing your good customers from suffering a severe set back which will injure your business as well as theirs.

# Refrigerating and Icemaking Machines*

MECHANICAL refrigeration has been practiced for well over three-quarters of a century, but for many years its use was naturally confined to large steam-driven units and marine use. Electrically driven ice and refrigerating machines first came into use about 1890 and their adoption has kept pace with the growth of the electrical industry. The tremendous growth in electrical distribution during the past twenty years, coupled with the perfecting of small motors in sizes ranging from ¼ horsepower up has made it possible for a household to have its own ice machine and within a comparatively few years there will be few up-to-date households still using the old time icebox.

The farm light and power dealer may think at first sight that this is a subject that does not concern him particularly, but quite the reverse is the case. Many dealers in this field will add thousands of dollars to their annual incomes the next few years through the sale of refrigerating machines ranging in capacity all the way from 200 pounds up to 2 tons in 24 hours. Quite a number of machines of various sizes are already running in connection with farm light and power plants and running very successfully.

### Prospects for Refrigerating Machines

Before taking up the subject itself, let us take a mental survey of all of the propsects in your territory and you will be surprised to find how many of them could use a refrigerating machine to advantage. First, are there any summer hotels? Next come butcher shops, general provision stores, dairies, drug and candy stores and, last but not least by any means, the well-to-do residents throughout your territory, whether they happen to live in the villages or on the farm. It may also surprise you to learn that sales of this equipment range from $500 to $3,000 or more, likewise the fact that a 2-ton refrigerating and ice making machine may be run very successfully in connection with a 3 to 5 KW farm light and power plant. It is being done right now and some of these plants have been in service for several years. In addition to being so messy, the cost of using natural ice has gone up to a point where the refrigerating machine is an excellent investment entirely apart from its many advantages of providing a reliable, dry., clean cold that keeps food indefinitely and in very much better condition. Ice costs nothing but cutting, carting and storing it at present labor prices, plus the high percentage of waste, actually makes it come higher for the same refrigerating effect than mechanical refrigeration.

### Power Required by Refrigerating Machines

In the case of small domestic size machines which are either built right into the ice box, placed on top of it or at a distance of 15 to 20 feet away in the basement, a ⅙ or ¼ horsepower electric motor is used. The motor is automatically controlled by a thermostat which opens and closes the switch with the rise or fall in temperature, in the same manner that the automatic controller of a water system starts and stops the motor with the fall and rise in pressure in the tank. One of the questions most frequently asked of the Editorial Department of Farm Light and Power is: "How long must the motor run every twenty-four hours?"

This will naturally vary in each case, depending upon the size of the icebox, its location, the condition in which food is placed in it, the character of the icebox itself and the number of times the doors are opened per day. An icebox with poor insulation or one on which the doors do not fit tightly, will probably keep the motor running continuously. This will also be the case where food is taken right from the stove and put into the icebox or

* Principles of Refrigeration, contributed by G. M. Dwelley, sales manager Kelvinator Corporation, Detroit, Mich.

where the doors are either opened very often or left standing open for some time. All of these conditions are encountered by the manufacturers of refrigerating machines many times over and in such cases the motor will naturally be kept running very much longer every day than would otherwise be necessary.

Given a good tight icebox of proper construction, in a fairly cool location, which is not opened more than ten or twelve times a day and the doors of which are not left standing open any longer than is necessary to put food in or take it out, and it will stay at a uniform low temperature with the motor running not over 8 to 10 hours a day in warm weather. Another important

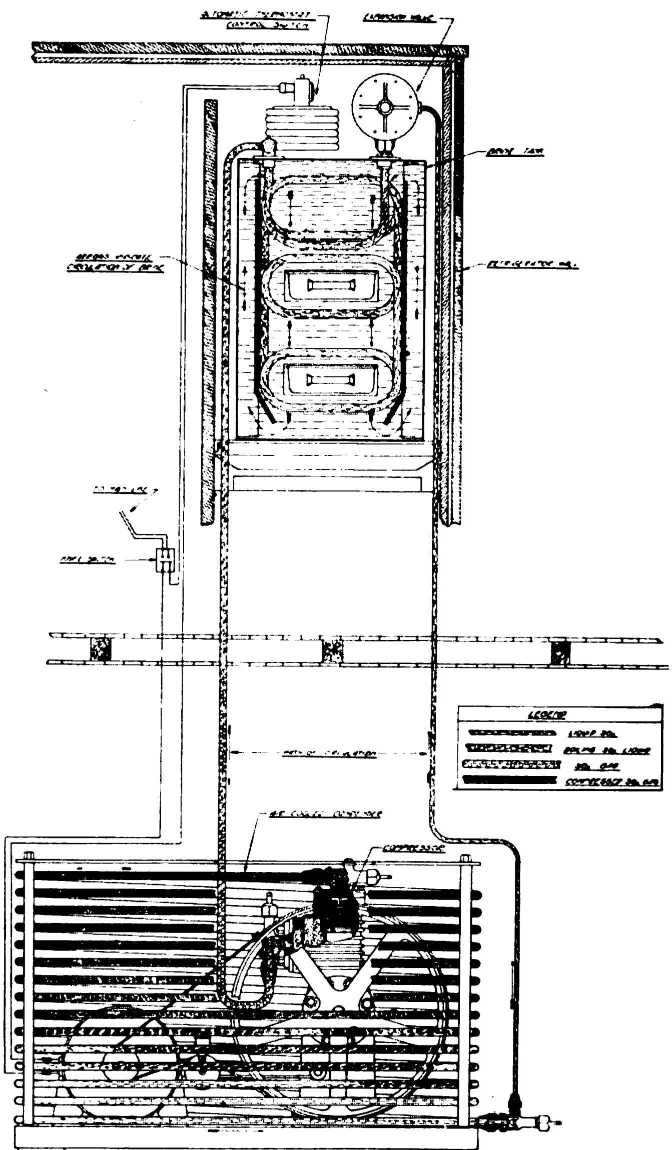
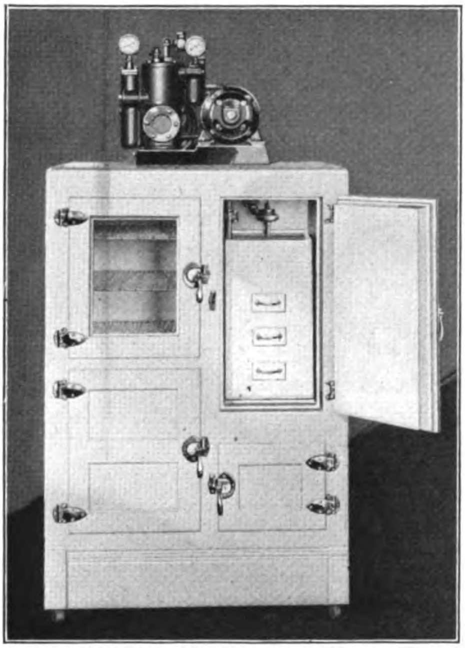



**Diagram No. 1. A study of this diagram will make clear the cycle through which the refrigerant passes from the compressor to the expansion valve and back to the condenser**

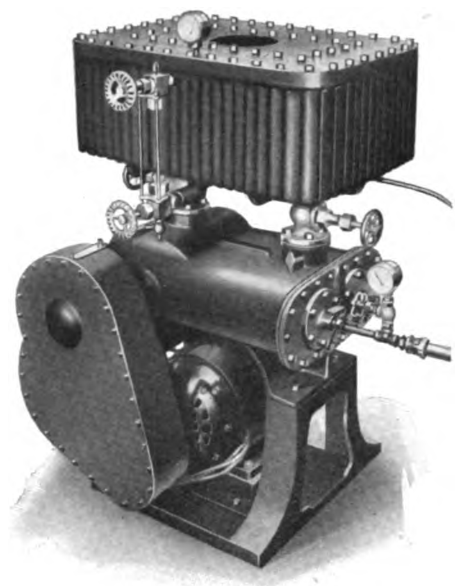
factor that controls the time of operation is the capacity of the machine with relation to the cubic volume to be cooled, representing its load. If the machine has sufficient reserve capacity it will always be able to handle the load easily, whereas if it is overloaded it will naturally have to run longer each day to make up for its lack of capacity.

### Don't Sell Too Small a Machine

What has been said so often in Farm Light and Power regarding the sale of too small a plant to meet the increased requirements of its owner a year or so hence, applies equally to the sale of refrigerating machines. A machine that is too small is never going to give very satisfactory service



"Refrigo" unit mounted on refrigerator



"Chillo" self-contained refrigerating machine

and, as in the case of the farm light and power plant, the owner's requirements will always increase. He will find the refrigerating machine such a great advantage that he will continually put it to new uses. Consequently, the dealer should always make sure of the customer's requirements and see that he is buying a machine large enough to give him the service desired. The small domestic machine rated at 200 pounds ice capacity per day is ample for the average family needs, but should not be sold for any other purpose.

Very small dairies will require a 500 pound machine and should probably use a half-ton size. Neither a dairy nor a summer hotel of any pretensions would find a 2-ton refrigerating machine too large to meet its requirements. These ratings represent the equivalent cooling effect of that amount of ice melted in 24 hours. Two tons of ice sounds like a great deal but as a matter of fact it is a comparatively small quantity and, in reality, the capacity of the machine is much greater than this equivalent since there is only one hour in the twenty-four during which there would be two tons of ice in an icebox and that is just after it has been newly filled, whereas the machine develops the cooling effect equivalent to two tons of ice at every moment during the 24 hours. In order that dealers may be better informed on this subject, a brief description of the principles of refrigeration is given here.

### Principles of Refrigeration

No. 1. Heat units are a form of energy, are therefore matter, and can't be changed, or destroyed; they can only be moved from one body to another.

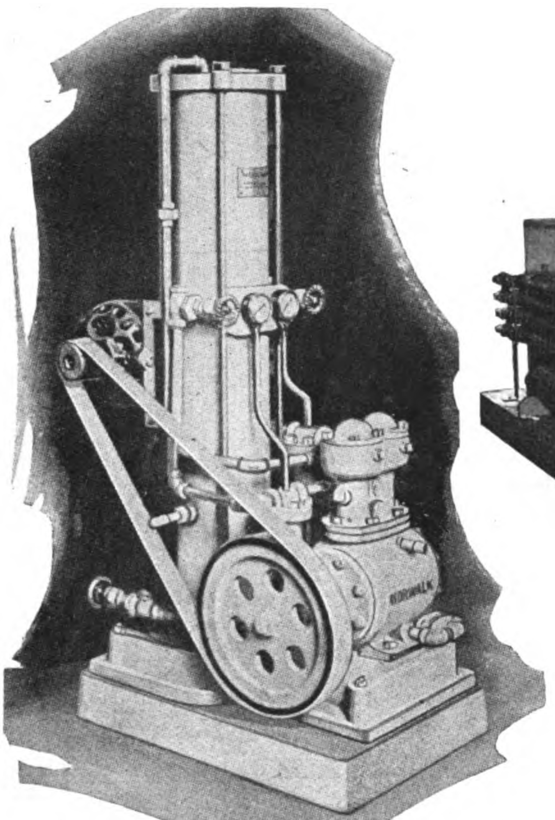
No. 2. Heat units always flow from the body of higher temperature to the body of lower temperature. Thus, if you put ice at 32° into a glass of water at 70°, the heat units always flow from the 70° water into the 32° ice, melting the ice and lowering the temperature of the water. If it were the other way, the ice would get colder and the water hotter.

No. 3. All matter has three states: solid, liquid and gaseous, the lowest temperatured being the solid, then the liquid, and then gas. Thus, water, solid (ice), liquid (water), gaseous (steam). The natural state may be either solid, (as iron) or liquid (as water) or gaseous (as air), but the addition of heat units will inevitably change the form of the substance to the step above (as heating iron makes it liquid) or the substraction of heat units will change the form to the step below (air to liquid air).

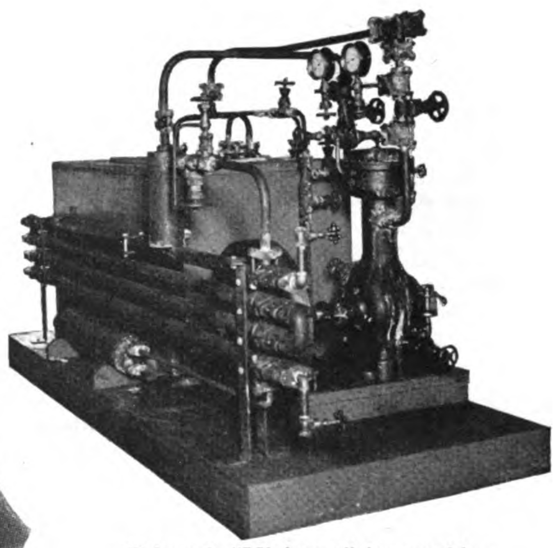
No. 4. No liquid will boil unless in contact with something of a higher temperature than its boiling point. Thus water, whose boiling point is 212° F. at sea level (atmospheric pressure, 15 pounds per sq. in.), will never boil on a stove heated to 200°, but must boil if on a stove at 220°.

No. 5. No two liquids have the same boiling point. Water boils at 212°, mercury at 676°, benzine at 176°, ether at 94°, ammonia at -30°, and sulphur dioxide at 15°.

No. 6. The temperature of the boiling point depends entirely on the



Norwalk refrigerating machine with two cylinder compressor



Triumph "Miniature" ice machine

Two types of small self-contained refrigerating and ice machines built in sizes ranging from 500 pounds up to 2- or 3-ton capacity in twenty-four hours. The Triumph machine is shown with a tank for ice-making

pressure. The higher the pressure, the higher the boiling point. Water at atmospheric pressure boils at 212°, at 100 pounds at 338°, at 200 pounds, 387°, and at 0 pound (vacuum) it boils at 32°. The table for sulphur dioxide follows:

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gauge Press. in lb. ............ | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 |
| Temperature, degrees Fahr. ... | 15 | 27 | 36 | 45 | 52 | 59 | 65 | 70 | 75 | 80 | 85 | 89 | 93 | 96 |

### "Boiling" Doesn't Always Mean "Hot"

Don't confuse "boiling" with "heat" as you ordinarily think of "heat"; namely, something hotter than your body temperaure of 98°. It seems foolish to think of ice as hot, yet ice at 32° is manifestly hotter than sulphur dioxide's boiling point of 15°, and sulphur dioxide, or $SO_2$, would boil merrily if set on a cake of ice. Anhydrous ammonia, boiling at 30° below zero sounds impossible, but this is red hot when compared with "absolute zero" (the absence of all heat) hundreds of degrees below it, at 491 degrees below zero (Fahrenheit). Suppose a quart of liquid sulphur dioxide is put in an open dish in an ice chest. The ice chest, say, is at 60°. This is 45° warmer than the boiling point of the sulphur so the sulphur will boil. Likewise, it will draw the heat units out of the air in the box and will keep on boiling till the air in the box is down to 15°. And, there's your refrigeration.

Just put a vent pipe in the box and keep pouring in sulphur and it will freeze that box into a solid lump of ice. It would be expensive though and the sulphur smells bad. This is where the machinery steps in. Up to now, all you have needed is a pan and some sulphur. However, when the sulphur has boiled and done its heat unit absorption stunt, or refrigeration, thus changing itself to a gas, we must change it back to a liquid without losing any of it and use it over again.

Refer again to the table for sulphur dioxide. You will note that at 85°, it will boil or condense under 50 pounds pressure. Thus if you take the gas formed by its boiling under atmospheric pressure in the refrigerator and compress it to 50 pounds, then discharge it into condenser coils also under 50 pounds pressure, it will condense back again to a liquid, provided that the air surrounding these coils is 85° or under. This will result, of course, because the heat units in the gas will flow out into the air which is cooler (see par. 2). If the temperature of the room in which the condenser coils are located be 70°, it will be necessary to put only 35 pounds pressure on the gas; at 59° only 25 pounds pressure will be needed. In any case, the gas is thus condensed to a liquid, but only under pressure. Let us say that it is at 60 pounds. We must now get it back to atmospheric pressure, or less, before it will boil at 15° or less, and thus furnish refrigeration again.

The liquid sulphur, under 60 pounds pressure, goes back up a return pipe, to the refrigerator, but just before it gets to the coils in which it is to do its boiling (expansion coils), a pressure reducing valve, commonly called the expansion valve, is introduced. In the Kelvinator, and in most of the best types of machines, this valve is automatic in its action. On the "high side" it has the sulphur under 60 pounds pressure. In the "low side" the pump, or compressor, is constantly drawing a vacuum through the expansion coils. Thus when the expansion valve lets through to the low side a small amount of sulphur, this immediately rushes through the expansion coils until it has expanded and thus reduced the pressure on it to atmospheric. Naturally, then it boils at a temperature of 15° and furnishes refrigeration again.

In the Kelvinator, and in several other machines, the expansion coils are immersed in a tank, which is filled with brine to prevent the liquid from freezing. This brine tank is used as a reservoir of cold, for the boiling sulphur draws the heat units out of the brine, and the brine in turn draws the heat units out of the air in the refrigerator. This means that the motor runs

less frequently and cuts down the number of starts, although the motor is in operation longer when it does run. The total consumption of current, however, is believed to be less when the brine tank is used. In the Kelvinator, and in several others, there are slides in the brine tank in which trays may be inserted. In these trays, cubes of ice may be frozen for drinks and frozen delicacies may be made.

### Cycles Through Which Refrigerant Passes

A study of diagram No. 1 will make the cycle of refrigeration clear. The sulphur boils in expansion coils in the brine tank; it is then led through the pipe on the left to the compressor. Here it is put under pressure and the gas is forced into the condenser coils. It goes into the top coil as a gas under pressure, but as contact with the cooler air causes the loss of heat units, in its forced descent to the lower coils it is gradually changed to a liquid under pressure in the lower coils. It then flows under pressure by the return pipe on the right, as a liquid, passes through the expansion valve and once more expands and boils. The thermostat is situated on top of the brine tank and it is this which automatically turns the motor on or off and thus starts or stops refrigeration.

It is only the surface of a cake of ice which furnishes refrigeration and it does this by the contact of air with the surface. Just as it is only the surface of the cake of ice which furnishes refrigeration, so it is only the surface of the brine tank which furnishes it, but as the surface of the cake of ice at 33°, its melting point, and the surface of our brine tank is held constantly at 22° by the thermostat, it is self-evident that the electric refrigerator has the best of it by 11°. But this is not all. The ice is constantly melting. A one hundred pound cake is put in. The next morning it is only 25 pounds. It is self-evident that the 25 pound cake gives only one-fourth the cold that the 100 pound cake did. The refrigerator was built for 100 pounds. Is it any wonder that food spoils? The brine tank never melts, and keeps the temperature of the box uniformly at 22°, regardless of the outside temperature.

Furthermore, the dampness in the air in the refrigerator, coming against the cold, immediately freezes to the side of the brine tank in the form of frost, and the electric machine thus not only cools the air, but dries and cleans it. Under average conditions, a Kelvinator when refrigerating boxes from 15 to 40 cubic feet runs its ¼ horsepower motor about 8 hours a day, with a consumption of 2.4 KWH. The smaller machine, refrigerating up to 15 cubic feet, runs its 1/6 horsepower motor about 8 hours a day, with a KWH consumption of 1.5.

There are several types of domestic electric refrigerating machines on the market. Some can only be installed on top of the box, some only under the box, and some, like the Kelvinator, can be installed anywhere up to thirty feet from the box. Some are air-cooled, most of the others being water-cooled. Above a certain size all refrigerating machines require water cooling.

Some machines are thermostatically controlled and automatic, and some are hand controlled. Some are belt driven from the motor, and some are gear driven, and directly connected. Some have fans to help cool the water (radiator types), and some have not. In the refrigerants used, there is little variation. The following refrigerants are commonly known. Ammonia, carbon dioxide, ether, air, ethyl chloride, methyl chloride, and sulphur dioxide. Most, if not all of the large machines, use ammonia, but in the small, domestic types, a few use ammonia, a few use ethyl chloride, and the great majority use sulphur dioxide.

### Some Valuable Pointers for Dealers

A few words of warning. You are interested in mechanical refrigeration because you are in the business of selling farm light and power plants and

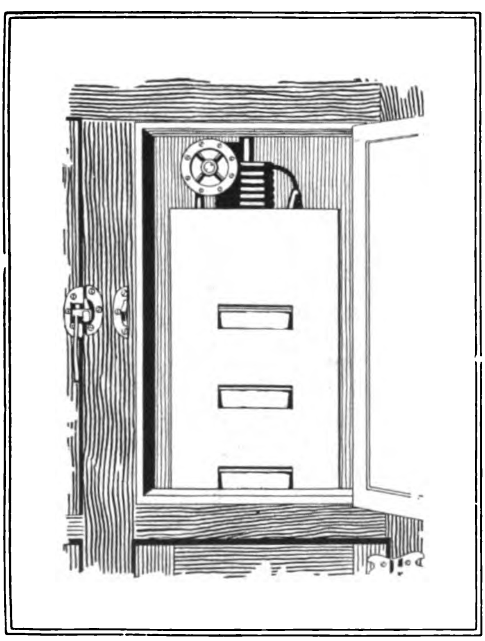
the more machines you can sell the better. But, and this is a big but, watch your step in taking on a line of electric refrigeration. The interest in this industry is universal. There are an average of three machines in the process of invention in every city in the country. There is approximately one new firm a month starting manufacture, and approximately one new firm a month going broke in the process. Look up the manufacturer. Ask him for a list of his cities in which he is represented. Write those cities. Ask his dealers how they like it, and ask the dealers for a list of their users. Write some users and ask them how they like it. Pick out users who have had the machines long enough thoroughly to test them.

Ask the editor of this magazine. Ask the Good Housekeeping Institute, or the New York Tribune Institute. Ask any institution which ought to know, and which you know to be disinterested. Don't grab off a lot of territory. We have found it most practical to confine any one territory to not over fifty miles in any direction from the dealer's store. Don't let anyone tell you that you can sell electric refrigerators without preparation. You must have a trained installer, and that means anywhere from two weeks to a month at the factory at your expense.

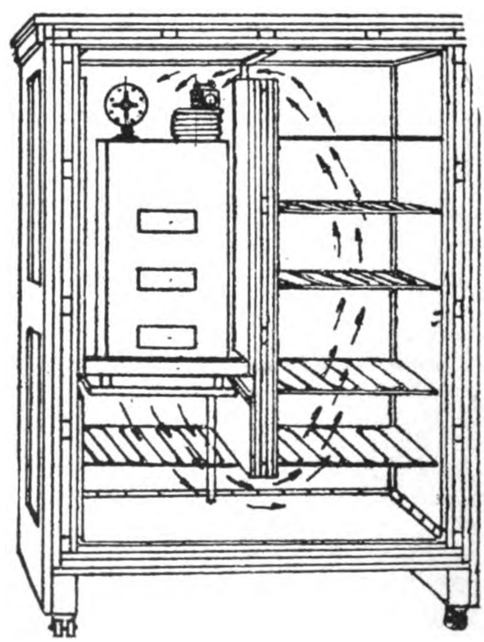
### Service Always the Basis of Success

And after you have taken on a line of electric refrigerators, don't sell them, and then fail to service them. If you do, you will hurt the industry in your territory for years to come. There is a tremendous field for electric refrigeration. The not very far distant future will see every home of medium income up, thus equipped. How soon that time comes in your neighborhood is more or less up to you.

If you are in the business to stay, I could not advise a better line than electric refrigeration. Not for immediate profits, as, like all things new (and the country at large still thinks electric refrigeration is new), the start will be slow; but for a steadily growing profit. Each machine sold (if you have the right one), will inevitably sell at least five more, and once you are established your sales grow by their own impulse.



**Expansion valve and brine tank used with small machine**



**Illustrating circulation of cold air from and back to brine tank**

# Electric Sewing Machines

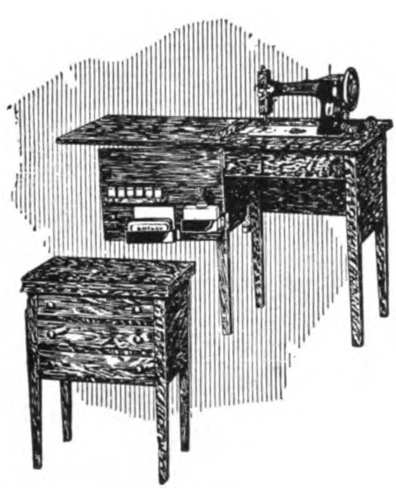
IN studying over the lines to which he will devote attention as a means of additional profit, the dealer should give the sewing machine a prominent place. Many thousands of the sewing machines now to be found in rural homes are either so antiquated or are so worn out from having had severe service for years that there is an excellent opportunity to sell new and up-to-date machines and, of course, today the only up-to-date sewing machine is that electrically driven.

There are now a number of types of sewing machines on the market that have been specially designed for electric drive and in which the electric motor is directly incorporated with the machine itself. They may be obtained with either 32- or 110-volt motors and represent compact and complete units that are easily carried around.

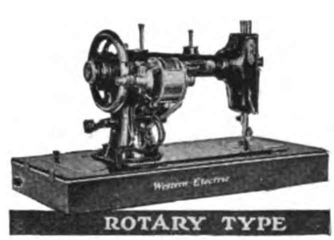
These machines range in price from sixty to one hundred and twenty dollars and represent a worth-while sale. They are often sold on the installment plan even by the manufacturers themselves, so the dealer would have to do likewise to encourage sales but he should have no difficulty in placing paper of this kind with his bank. On the hundred dollar machines they would be made to extend over at least a year. Of course, these are small payments but the old time sewing machines were sold on even easier terms and it should be borne in mind that any payment gives the dealer a good excuse for calling and making additional sales.

Where the machine now owned by the prospect is of so recent purchase as not to make an exchange desirable, it can always be converted into a power machine very readily by the addition of one of the numerous makes of special motors designed particularly for this service. These can be had for either low or standard voltage and with the aid of one demonstrating outfit, quite a number should be sold in the course of a year.

The fact that you carry several demonstrating outfits of different types along with you on your calls also makes a strong appeal to those who have not yet put in plants of their own as it gives them concrete evidence of the numerous conveniences and comforts they can enjoy when they have electricity in the house. The strongest appeal is made to the eye and not to the mind. That is why a demonstrating outfit of any kind, even when it isn't actually operated, is a whole lot stronger appeal than any sales talk ever invented.



"White"




"Western Electric"

**Illustrating two models of up-to-date and popular electric sewing machines**

Picking the right time for the demonstration goes a long way toward making sales of sewing machines just as it does of other appliances. More sewing is done in winter than in summer. You can arrange with your prospect to have a little private sewing test. Tell her to get together all of the sewing she has in prospect, probably a two weeks' job under ordinary conditions. Then arrange to leave a demonstrating machine for several days on condition that she uses it steadily with a view to seeing how much less time is required to do the two weeks' sewing. This will close a sale in nine cases out of ten.

## Dish Washing Machines

WHETHER there is a good prospect of adding to your profits by the sale of dishwashing machines will depend very largely upon the nature of your territory. But there are very few sections of the United States today where there isn't a good prospect of selling at least some dishwashing machines if the dealer is alive to his opportunity. The average farmer's wife can hardly be said to be such a prospect. She'll buy a washing machine and an electric iron and even an ironing machine but you'll find a whole lot more sales resistance when it comes to a dishwashing machine because dishwashing isn't considered heavy labor, or even a disagreeable task.

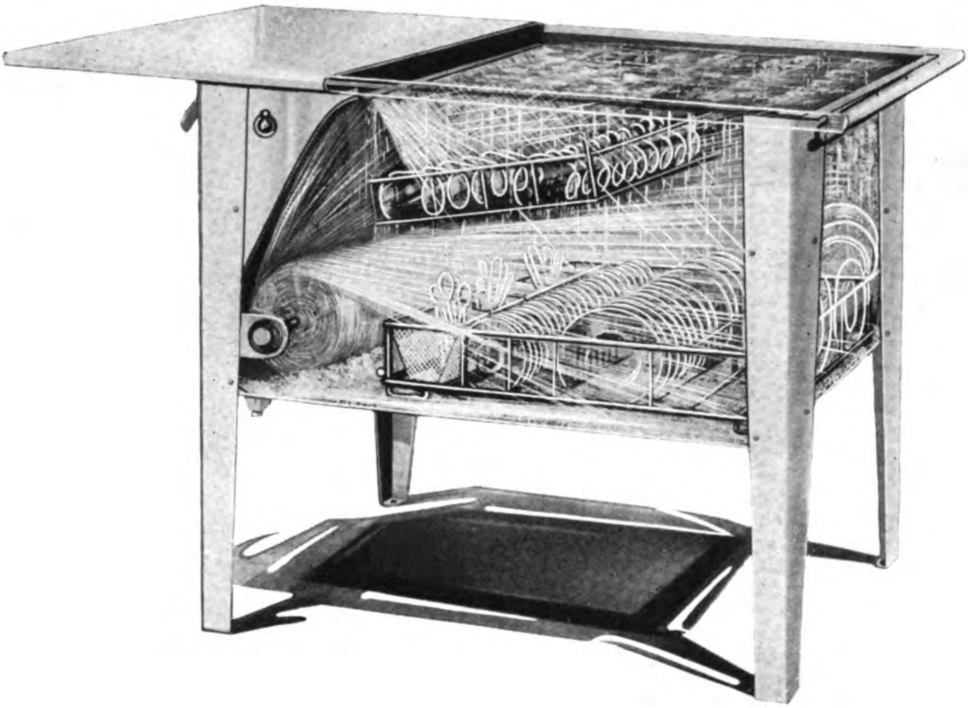
But every small hotel, every summer boarding house and resort hotel, and all well-to-do people who live in the country in summer are good prospects. No matter how small a hotel is, there is a tremendous amount of dishwashing necessary and in these days of high-priced, scarce and unsatisfactory domestic help, anything that will reduce the number and at the same time do the work more satisfactorily will be welcome.

There are several practical types of dishwashing machines on the market today that can be run in connection with any fair sized farm light and power plant and that do not involve any particularly heavy outlay for their purchase. Apart from plumbing and wiring connections which are simple to make, these machines require no special installation, nor do they call for any particular amount of education in their use to get the best results. In this respect they are quite as simple, reliable and efficient as the clothes washing machine itself.

The accompanying illustration shows in section one type of washing machine and its method of operation. As in the case of clothes washing machines, various makes differ more or less in their construction, but most of them operate on pretty much the same principle. The machine is filled

**Electric churns and ice cream freezers are good profit makers**

with hot, soapy water to a certain level, the dishes scraped free of large particles of food and stood on edge in a wire basket, cups and other irregular pieces being placed in special baskets while knives, forks and spoons are also placed in baskets of their own. The machine is then closed and the motor started. This throws the hot soapy water against every part of the dishes and cleans them thoroughly in pretty much the same way that you would clean a plate with a hose delivering hot soap suds under high pressure.



**Phantom view of a Western Electric dish-washing machine showing method of operation**

After a few minutes' operation, the water is drained off and fresh hot water run in to the same level, the motor is then started again and the operation repeated, making the china and silverware thoroughly clean. If sufficiently hot water has been used, the dishes will not need drying.

Put the dishwashing machine down on your list as a possibility and keep your eyes open for opportunities. A machine that will save its own cost in wages the first year will be a welcome addition to any large kitchen.

# Electrical and Technical Terms in Common Use

**Absorption, Luminous,** Every body not absolutely transparent absorbs some of the light passing through it, ranging from 10 to 50 per cent. with the different varieties of glass. With colored glass, the absorption is much greater, reaching over 70 per cent. or more with dark blue and green glass.

**Accumulator,** Another term for the storage battery, also technically termed a secondary battery.

**Acidometer,** More commonly termed a hydrometer.

**Adapter,** A pipe fitting or screw coupling with a different sized thread on each end, for connecting fittings in wiring work.

**Air,** Dry air at atmospheric pressure (14.7 lb. per sq. in. at sea level) is a dielectric representing the standard of specific inductive capacity, or 1. See Dielectric. When dry, air has a high resistance but this is lowered as the amount of moisture increases. Air consists of oxygen, 21 volumes, nitrogen, 79 volumes.

**Air Condenser,** One in which air is employed as the dielectric. See condenser.

**Air Gap,** The space between the armature and the field poles of a motor or generator. Also a gap provided on a high tension magneto or on an induction coil, to prevent imposing too great a stress on the windings as occurs when the points of a spark plug burn too far apart. More commonly known as a safety spark gap.

**Alarm, Electric Burglar,** Usually consists of a bell and battery in circuit with a spring contact, so that the circuit is closed by the opening of a door or window. The bell then continues to ring until the opening is reclosed or the battery runs down. The contact may also be concealed under carpet or matting so that walking on the latter closes the circuit.

**Alarm, Automatic Fire,** Same circuit as burglar alarm but with thermostatic circuit closers. These are devices containing strips of metal which are easily affected by a moderate rise in temperature. Under the influence of heat in excess of 150° F., the metal strip bends and makes contact with a stationary terminal, ringing the bell. Several of the circuit closers are used in different parts of a building, each being connected directly in series with the bell and battery so that the closing of any one of them will ring the bell.

**Alarm, Overflow and Water-level,** Circuit same as a burglar or heat alarm with contract operated by a float in the water to close the circuit. May be used to indicate either high or low level in open tanks and cisterns.

**Alloy,** A mixture of two or more metals. Two important uses are the fusible alloys employed in fuses which melt at low temperatures and that for high resistance wire. See German Silver.

**Alternating Current,** Usually abbreviated to A. C. A current that reverses its polarity or direction with each cycle. Employed on all high-tension transmission lines because A. C. can be sent long distances at very high voltages and stepped down to the service voltage where needed through a transformer. Makes transmission more economical by decreasing voltage drop and permiting use of smaller wires. Only use in connection with farm lighting plants is in the magneto for ignition. The magneto is an A. C. generator.

**Alternation,** Change in the direction of a current. See Cycle.

**Alternator,** An A. C. generator. Not used on farm lighting plants. See Magneto.

**Amalgam,** An alloy containing mercury.

**Ammeter,** An ampere-meter, or current-measuring instrument.

**Amperage,** The amount of current flowing in a circuit.

**Ampere,** The amount of current that will flow through a resistance of one Ohm under a pressure of one volt. The practical unit of current flow. See Ohm, Volt and Ohm's Law.

**Ampere-hour,** Equivalent to a current of one ampere flowing for one hour. The unit employed for rating storage batteries.

**Ampere Hour Meter,** An instrument employed to indicate the charge and discharge of a storage battery in ampere hours.

**Ampere-turn,** A unit employed in calculating the winding of all electro-magnets, such as the armature and field magnet of generators and motors. A current of one ampere flowing through ten turns on the core of an electro-magnet represents ten ampere-turns; three amperes flowing through the same coil would represent thirty ampere-turns.

**Angle of Lag,** The displacement of the magnetic axis of the armature core of a generator in the direction of its rotation, due to the movement of the armature.

**Angle of Lead,** Displacement given to the brushes of a generator in the direction of its armature to compensate for the lag, termed "Positive lead." In a motor, the brushes are set the other way, giving them a "negative lead."

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**Annunciator,** A device consisting of several electro-magnets, the operation of which releases an "annunciator drop" showing the location from which the call or signal has been sent and accompanied by the ringing of a bell or buzzer which forms part of the annunciator and is connected in series with all of the drops.

**Anode,** The positive plate of a battery. In electro-plating, the plate from which metal is supplied to the bath; a copper anode, gold anode, etc.

**Arc,** The flash produced by a heavy current jumping across an air gap between two electrodes or terminals. To arc, arcing.

**Armature,** The revolving member of a D. C. generator or motor. The small piece of iron placed across the poles of a permanent magnet, termed a "keeper." A pivoted or hinged piece of iron designed to be attracted by an electro-magnet as in a bell, buzzer, automatic cut-out, etc.

**Armature Coil,** One of the windings of a generator or motor armature.

**Armature Core,** The foundation on which the armature windings are placed, usually consisting of a large number of thin discs, or punchings, with slots for the reception of the windings and assembled on the armature shaft to which they are clamped. These armature discs are insulated from each other by varnish or thin paper to minimize Eddy Currents.

**Armature Disc,** See above.

**Armature Clearance,** See Air Gap.

**Armature, Hinged,** Type employed in electric bells and buzzers.

**Armature, Multipolar,** One having a number of poles greater than two, as represented by the numerous slots in the discs in which the windings are placed. A two-pole armature is termed "bi-polar."

**Armature, Polarized,** Made of steel which has been magnetized or converted into a "permanent magnet," so that its poles always remain the same regardless of the change in polarity of the electro-magnet of which it forms a part. Chiefly used in telegraph relays, magneto ringing bells used on telephones, etc.

**Armature, Shuttle,** The simple H-type used in magnetos.

**Arm, Rocker,** The brush support on a generator or motor, and movable so that the brushes may be set at a neutral point. Modern small generators and motors are so designed that no adjustment of the brushes is necessary for this purpose and their location is fixed.

**Armored Cable,** Two or more conducting wires encased in insulation and protected by spirally wound steel armor.

**Automatic Controller,** A pressure-operated switch for cutting in and out of the motor of a domestic water system or an air compressor, etc. May be set to operate over a certain pressure range, as 20 lb. low and 40 lb. high, in a water system. Whenever the pressure drops to 20 lb., the controller starts the motor and keeps it running until a pressure of 40 lb. is reached in the tank. See text on water systems.

**Automatic Cut-out,** A device employed in the circuit between the battery and the generator and designed to break the circuit when the voltage from the generator falls below that of the battery. Consists of an electro-magnet having two windings, a voltage coil of high resistance in shunt with the main circuit and a current coil of heavy wire in series, both coils acting on the same armature which carries contact points so that its movement closes or opens the circuit between the generator and the battery. When the generator is starting up, the voltage coil attracts this armature as soon as the voltage exceeds that of the battery sufficiently. The movement of the armature then connects the current coil in series so that the current passes through it from the generator to the battery and the contacts are held together more firmly. When the generator voltage drops below that of the battery, the current from the latter overcomes that of the generator so that the flow is reversed and the armature of the cut-out is then repelled by the electro-magnet and the circuit is opened disconnecting the battery and generator. Also termed a "Reverse current relay."

**Automatic Stop,** A device used in connection with an automatically controlled plant to stop the engine when the battery is fully charged. It consists of a contact at the maximum point on the scale of an ampere hour meter. The ampere hour meter incorporates a compensating device to allow for the 10 per cent. loss in charging so that when the ampere hour meter indicates that 100 ampere hours have been put into the battery (assuming this to be its capacity) it has actually received 110 ampere hours of charge. When the pointer reaches the upper end of the scale it strikes a contact which opens the ignition and stops the engine. An automatic starting device may also be operated in the same manner, that is, when a certain amount of current has been drawn from the battery, say 10 or 20 per cent., the ampere hour meter closes a circuit which starts the engine and allows it to run until the battery is again fully charged.

**Automatic Switchboard,** Not a switchboard in the ordinary acceptance of the term, but a set of interacting relays by means of which an automatic type of plant (Kohler, Holt, etc.) is started by turning on a light or a switch at a distance from the plant, as by the cutting into the circuit of an automatic water system. Closing a circuit, as by turning on a light, sends current through an electro-magnet which attracts its armature carrying contacts, which in turn close the circuit between the starting battery and the generator and also closing the ignition circuit. As soon as the engine starts and begins to speed up, the starting battery circuit is opened and the voltage of the generator closes a relay which connects it with the line, lighting the lamp, starting a motor on a water system, etc. The entire operation only takes 10 to 15 seconds. When the last light or motor on the line is switched off, the generator relay opens and cuts off the ignition circuit, stopping the engine and leaving the relay in position to start the engine again whenever the circuit is closed. Used on plants not equipped with a battery to store current, the plant itself starting up automatically whenever current is wanted. The only battery used is the small one employed for turning the engine over to start and this is kept charged automatically by the generator.

**BX,** Trade term for armored cable.

**Babbitt,** An alloy of lead, tin and antimony used for bearings.

**Base,** The porcelain insulating support of a rosette or lamp.

**Battery,** A combination of elements designed to produce a current by direct chemical action, as in a primary battery, or by chemical reaction as in a storage battery. A common example of the primary battery is the dry cell; the storage battery is a secondary battery because it must first be charged before it will produce a current. The term battery is interchangeably used to refer to either a cell or a group of cells.

**Battery Acid,** Chemically pure sulphuric acid used in making the electrolyte or solution used in storage batteries. See Electrolyte.

**Battery, Dry,** An open-circuit cell (one from which current may only be drawn for comparatively short periods) consisting of a zinc container forming the cathode and a carbon rod the anode, the intervening space being packed with manganese dioxide as a depolarizer and saw dust, fullers earth or similar absorbent material. This is then saturated with a strong solution of sal-ammoniac and water and the cell sealed up. Not literally a dry battery since when it becomes actually dry it is dead.

**Battery Mud,** The deposit of sediment in the jars of a storage battery and consisting of the active material shed by the plates in service. Heavy deposits in a short time indicate overcharging and charging at too high a rate. Must never be permitted to reach bottoms of plates as a short circuit will result and ruin the battery.

**Battery, Secondary or Storage,** A combination of lead plates, or grids, which have forced into them under heavy pressure an oxide of lead, termed the active material, and immersed in an electrolyte consisting of sulphuric acid and water. Each cell consists of a group of plates of an even number of positives and an odd number of negatives so that there is always one more negative than positive plates in a cell. After manufacturing and assembling the plates, each group being held apart by fastening to heavy lead straps at their tops, they are placed in the jars containing the electrolyte with wood or hard-rubber separators between them and subjected to a forming process, which consists of charging and discharging the cell, resulting in the formation of peroxide of lead at the positive plates and spongy metallic lead at the negatives on charge and sulphate of lead on discharge. Each cell delivers current at a potential of two volts and requires current at a slighter higher voltage to charge it.

**Battery, Edison Storage,** A combination of nickel-iron elements in an alkaline solution giving approximately 1.4 volts per cell. Not adaptable to many uses to which the lead cell is put owing to its high internal resistance. Seldom used with farm light and power plants.

**Bearing, Self-oiling,** Also known as a ring-oiling bearing having a loose ring on the shaft dipping in a small oil well. Anti-friction bearings, such as roller and ball types are sometimes erroneously considered self-oiling, but this is not true. While they require very little, they are usually packed in light grease to protect them from rust.

**Beaume Hydrometer,** See Hydrometer.

**Bell, Electric, Call, Vibrating,** Terms applied to the common type of bell in which a hinged or pivoted armature carrying contacts is attracted by an electro-magnet. The hinge, or spring of the armature holds it in contact when no current is passing and alternately makes and breaks the circuit when the electro-magnet is energized by the current.

**Bell, Electro-mechanical,** One in which the attraction of its armature by the electro-magnet releases a spring or weight-driven mechanism sounding the bell a certain number of times or for a given time. Some fire alarm bells are of this type.

**Bell Hangers' Drill,** An extra long drill bit used for boring through walls and floors in running wiring in old houses.

**Bell, Magneto,** One having a polarized armature so that it may be operated by a magneto or alternating current. Hand ringing telephone bells are of this type.

**Binding Posts or Screws,** For fastening the bared and scraped ends of the wiring of a circuit to the switchboard, fuse block, socket or similar device.

**Box, Starting,** Graduated resistance, or rheostat, used for starting D. C. motors above a certain size. Motors larger than 1/4 or 1/3 horsepower, usually require starting boxes.

**Brake, Electro-magnetic,** A brake band or shoe designed to be drawn against a rotating brake drum or wheel, to bring a motor to stop. Used on elevator motors.

**Brasses,** The split brass or bronze bearings as used on some connecting rods and crankshafts.

**Breaker Box,** Case or housing holding the contact breaker of the magneto or ignition distributor. See Contact Breaker.

**Bronze,** An alloy of copper and tin, with small quantities of lead and zinc.

**Brushes,** The pieces of carbon that are held against the revolving commutator by springs in generators and motors, serving to conduct the current produced by the generator to the outer circuit and to lead the current to a motor to operate it. Formerly made of copper.

**Brush Adjustment,** Shifting of the position of the brushes on the commutator by moving the rocker arm to minimize sparking. Not necessary on most farm light plants or motors as this is taken care of in the design. See Arms, Rocker.

**Brush Holder,** A small copper box open at one end and having a spring at its inner end which holds the brush against the commutator. The holder is attached to or forms part of the brush arm.

**Brush Spring,** See above.

**Brush, Third,** Most small generators and motors have two brushes regardless of the number of poles in the fields or armature. A third brush is sometimes used in a generator to regulate its output, being connected to a series winding and a resistance. Employed on some automobile starting and lighting generators, to prevent the generator from producing an excessive current and burning out.

**Bus Bar,** A copper strip or bar employed on the back of switchboards and through which the necessary connections are made. Generally used only on larger switchboard than those employed on farm light plants.

**Bushing,** An insulator through a connecting wire is passed; hard rubber bushings are used in lamp sockets, porcelain bushings for carrying wires through walls.

**Button, Push,** A switch operated by the pressure of a button, or a temporary circuit-closer on open circuits such as those of call bells and annunciators, the circuit being normally held open by a spring under the button.

**Buzzer,** Similar to an electric bell but without a gong.

**C,** Symbol of current or current strength as in Ohm's law.

**C = E/R,** C indicates the current strength, E indicating electro-motive force, usually written e.m.f., and R the resistance.

**Cable,** An insulated conductor of large diameter. Duplex cable or multiplex cable, two or more insulated conductors enclosed in an outer covering of insulation holding them together as a single cable.

**Cable Box,** A terminal box in which a cable is separated into its component conductors which are then run separately. Sometimes placed underground and in other cases on a pole (telephone service).

**Calibration,** Determination of the accuracy of the readings of an instrument, usually by comparison with a standard instrument of the same type.

**Cam,** An eccentric shaped piece of metal fastened to a shaft to convert rotary into reciprocating motion, as the cams on a gasoline engine. Usually elliptic in form; inlet valve cam, exhaust cam, igniter cam.

**Candle,** The unit of illuminating power. Candle power, the amount of illumination given by an electric bulb as compared with the standard candle. Current consumption is now used for rating bulbs instead of candle power, as a 20 watt bulb.

**Candle Socket,** A socket formed to imitate a candle used with candelabra and standard round lamps.

**Canopy,** Ornamental cover for the connections to a lighting fixture.

**Canopy Block,** Wooden block to be placed beneath fixture canopy in open wiring.

**Canopy Switch,** A chain or pull-operated switch mounted in a canopy for fixtures that cannot conveniently be controlled by a wall switch.

**Capacity, Battery,** The amount of current in ampere-hours that a storage battery will deliver from the fully charged state to a safe point of discharge.

**Capacity, Dielectric,** Same as Specific Inductive Capacity. The capacity of a dielectric (air or other insulators) in retaining an electro-static charge. A characteristic of condensers.

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**Carbon,** A conductor made of coke, gas tar, petroleum residue, graphite, or a combination of these materials, moulded into form with some binding substance under heavy pressure. Used for brushes, contacts of circuit-breakers and other contacts carrying a heavy current.

**Carbureter,** A device in which liquid fuel is converted into fine spray or vapor and mixed with the correct proportion of air to render it explosive, usually ten to fourteen volumes of air to one of gasoline vapor. Mixing valves service the same purpose but differ from a carbureter in having no float chamber in which a supply of fuel is maintained.

**Carrying Capacity,** The number of amperes that a wire or other conductor of given size will carry without excessive heating. See table of carrying capacities.

**Cartridge Fuse,** A fuse in the form of a small cylinder of fibre with ferrules or terminals fitting in clips on the panel board. Generally used on the plant switchboard.

**Cement, Electric,** A compound having high insulating properties, such as sealing wax, used for filling the holes in the back of fuse blocks and switch bases through which screws have been inserted to hold the parts on the face of the block and designed to prevent a conductor from coming in contact with them.

**Centrifugal Governor,** Also termed a Mechanical Governor, consisting of a pair of balanced weights on a spindle connected with the throttle of the engine. At low speeds a spring holds the weights together in which position the throttle is open. Increasing speed causes centrifugal force to overcome the pull of the spring and partly close the throttle regulating the speed of the engine.

**Chain Socket,** Also termed a pull socket; one having a flexible chain instead of a key for turning the current on and off.

**Charge,** The amount of current sent into a storage battery. The quantity of electricity present on a body or conductor. Electro-static charge, the amount of electricity represented by the charge of a condenser.

**Chemical Reaction,** The process that takes place in a storage battery when it is charged, also when a current is drawn from it, resulting in the conversion of lead (and sulphuric acid) in the different forms in which it is present in the plates when the battery is charged, into sulphate of lead.

**Circuit,** The conducting path for the current, consisting of the wires or conductors and the apparatus to which they are connected.

**Circuit Breaker,** A device to open a circuit automatically in order to protect the apparatus in it when too much current flows through it, as an overload circuit breaker; or to prevent a reversal of the current when the voltage drops too low, termed a no-voltage circuit breaker, reverse current relay, automatic cut-out and the like. Used to protect the storage battery.

**Circuit External,** That portion of the circuit not included within the windings of a generator. Circuit Internal, that through the windings.

**Circuit, Grounded,** A circuit one side of which is represented by an earth or ground return, as in telegraphy and street car operation using a single overhead wire, also the ignition circuit of the engine, one side of which is grounded on the engine itself. A grounded circuit is also one in which the positive side has become accidentally grounded so that the current returns to the generator through the ground instead of reaching the appliances on the line. See Ground.

**Circuit, Parellel,** One in which all appliances are connected to both sides of the circuit so that they all receive current at the same voltage. The circuits of a farm light and power plant are parallel, or multiple circuits.

**Circuit, Series,** One in which all appliances are connected in series, as a set of dry cells or the cells of a storage battery.

**Circuit, Series-Parallel,** A combination of the two forms given above.

**Circular Loom,** An insulating covering through which wires are run.

**Cleat,** Porcelain support for running opening wiring, holding two wires.

**Clock, Electric Annunciator,** One that closes the circuit of a dry battery through an annunciator or rings a bell at stated times.

**Clock, Self-winding,** One in which a dry battery and small motor wind the clock at certain intervals.

**Clock Switch,** See Time Switch.

**Clockwise,** Said of an engine that turns in the same direction as the hands of a clock, from left to right.

**Coil,** The winding of any electro-magnet, as armature and field coils in a generator. Coil of a solenoid. See Helix.

**Coil Induction,** Two coils wound one over the other on a soft iron core usually of fine iron wire, one of coarse heavy wire of few turns, termed the primary and the other of a great number of turns of very fine wire. By mutual induction a current sent through the primary, the circuit then being suddenly opened, is transformed or stepped up, to a much higher voltage in the proportion that the turns of the secondary winding bear to the primary winding. The current sent through the primary renders the soft iron core strongly magnetic; when the current is suddenly shut off, this magnetism is converted into a current in the secondary winding. Also termed a transformer. When current is sent into the secondary, the voltage is stepped down.

The ignition coil is a step-up transformer to produce the high voltage necessary for a spark at the plug. Pole line transformers are stepdown, converting the high-tension current used in long distance transmission to the low voltage for service in houses.

**Coil, Resistance,** One wound of special high resistance wire and used to impose a given amount of resistance on a circuit. A resistance coil is used in all voltmeters.

**Coil, Heating,** Made of high resistance wire to convert the current passing through into heat. Used in toasters, electric irons, stoves, etc. Also in a so-called Heat Switch employed on automatic farm light plants to open the starting circuit between the battery and generator in case the engine fails to start after a certain time in order to protect the starting battery. Sometimes termed an Emergency Stop, or Heat Switch. Also termed a Heating Element.

**Collecting Ring,** Used on A. C. generators to lead current from the rotor (corresponds to the armature of a D. C. generator) to the external circuit. Also on the tower of wind-driven plants to permit the generator to turn with the wind wheel without crossing or twisting wires.

**Combination Switch,** A. D. P. S. T. Switch mounted on the same block with fuse receptacles.

**Commutating Pole,** A small pole placed between the main poles of the field of a generator to prevent sparking. Also termed an "interpole."

**Commutator,** The device by means of which the A. C. current generated in a D. C. generator is transformed into direct current. Consists of a number of copper bars or segments, placed on end around the shaft with insulation between them and upon which the brushes bear. The bars are now usually molded directly in the insulation.

**Commutator Flats,** Caused by excessive wear on certain segments due either to heavy sparking at those particular segments resulting from a shorted or grounded armature coil, or the fact that the armature shaft is out of alignment.

**Compass,** A device consisting of a magnetized hard steel needle or bar supported on a pivot and free to turn. Being of hard steel, the needle is a permanent magnet and responds to the magnetic attraction of the earth, so that the south pole of this magnet points north. This is termed the north-seeking, or north pole. See Magnetic Attraction.

**Composition, Molded,** Molded insulation used on plugs and similar devices.

**Condenser,** A device for storing an electrostatic charge and returning it to the circuit when the latter is suddenly opened. A condenser is used in connection with the ignition system and is shunted around the contact points. When contact is made the condenser stores a charge and when the contact points open, this charge or additional current is fed back to the circuit. It prevents sparking at the contact points so that they do not burn away as rapidly as they would without it. Consists of alternate layers of tin foil and paraffined paper or mica. Alternate sheets of tinfoil are connected together and each group to a terminal or binding post.

**Conductivity,** Relative power possessed by different substances of conducting current Pure silver is taken as the standard, soft copper is next. The harder copper is the poorer its conductivity.

**Conductor,** Any substance permitting the passage of current.

**Conduit,** Soft iron pipe used for running wiring.

**Conduit Fittings,** Outlets, boxes, etc., used in conduit wiring and generally known by various trade names as "Condulets," etc.

**Connector,** A sleeve, clamp or similar device with screws for holding the ends of wires in good electrical contact.

**Contact,** Placing of two wires or terminals together so that current may flow, as the contact points in the ignition system. Or, a sliding contact, as the brushes bearing on the commutator.

**Contact Breaker,** Device for closing and opening a circuit quickly, as in the breaker box of the magneto or of the ignition distributor. Also is the automatic cut-out.

**Contact Point,** The points which come together to close the circuit in any of the above devices. An alloy of iridium and platinum makes the only contact points that will give extended service without burning away or oxidizing and preventing the passage of the current. Silver and monel metal also used but require more cleaning and trueing up.

**Controller,** A device consisting of a series of contacts and resistances so that the strength of the current fed may be regulated for starting; also an automatic switch as used on water pressure systems. See Article on Water Systems. See Automatic Controller, Box, Starting.

**Converter, Rotary,** A double-wound machine operated by comparatively high voltage A. C. and generating D. C. at service voltage. Used on street railway systems. Converter, obsolete term for step-down transformer.

**Copper Bath,** Solution of sulphate of copper used in electro-plating.

**Cord, Flexible,** A number of fine copper wires twisted together to form the equivalent of a larger size, as No. 18 cord is the equivalent of No. 18 wire. This is the smallest size permitted by the underwriters for drops. Two of the conductors thus formed are twisted together, each being insulated with rubber and cotton or silk.

**Core,** The iron or soft steel foundation upon which windings are placed, as an armature core, field cores, core of an induction coil or transformer. Core discs, see Armature Discs.

**Counter E. M. F.,** A potential or e. m. f. flowing in the reverse direction or counter to the current being sent through the circuit. An electric motor, having all the essentials of a generator, produces a potential when running and this tends to reduce the potential operating it. This counter e. m. f. increases the resistance of the motor when running as compared with standing idle and explains why a starting resistance is necessary with motors of ½ HP. or larger.

**Cross,** An accidental contact between two conductors resulting in a short-circuit.

**Crowfoot,** A threaded support, screwed to the wall or ceiling and tapped with a ⅛, ¼ or ⅜ thread into which the pipe part of a fixture is screwed.

**Current,** The flow of electricity tending to equalize a difference of potential in different parts of a circuit. A current is assumed to flow from a positive terminal, whether of a battery or a generator, through the outside circuit and back to the negative terminal.

**Current, Constant,** One of unvarying strength. The now obsolete open arc lights were run on a constant current circuit, being connected in series.

**Current, Continuous,** Same as direct current, D. C. Current as produced by the generator is always alternating, but on a D. C. generator the commutator "straightens" it out into a continuous, or direct current.

**Current Intensity,** Current strength of which the unit is the ampere.

**Current, Secondary,** The high-tension current induced in the secondary winding of an induction coil or transformer.

**Curve, Characteristic,** A graphic indication of the relation between any two interdependent factors, such as the voltage and current output of a generator. The curve is laid out on square ruled paper, the horizontal and vertical lines forming these squares being termed co-ordinates. One set, as the vertical, may represent amperes while the horizontal represents volts. Each point on the curve then shows the current produced at a certain voltage, while a second curve may indicate the horsepower. Typical curves, charching and discharging curves of a storage battery, giving volts and hours of charge or discharge at various points; horsepower curve, showing power developed by an engine at different speeds, etc.

**Cut In,** To connect a device or appliance in a circuit, cut-out being the reverse of this. See Automatic Cut-out, also termed a Magnetic Cut-out.

**Cut-out, Safety,** Fuse block and fuses inserted in line to protect devices in case of overload, short circuit, etc.

**Cycle,** The period during which an A. C. rises from zero to a maximum, returns to zero and rises again to a maximum in the opposite direction. The standard A. C. used is 60 cycle, or 120 alternations per second. This is too rapid for the eye to follow, so that a light appears to burn steadily as when fed with D. C. Lights on 25 cycle A. C. flicker perceptibly. Any series of operations repeated in a regular order, as the four-part-cycle of the gasoline engine, suction, compression, explosion, exhaust. Also the two-part, or two-cycle engine, in which intake and compression occur on one stroke, explosion and exhaust on the next.

**Cycle of Charge and Discharge,** One complete charge, followed by a complete discharge of a storage battery, is termed a cycle and the life of a storage battery is usually given as 300 cycles.

**Damping,** Preventing the needle, or indicator, of an instrument, or the spindle of a governor from vibrating or oscillating; steadying.

**Dash-pot,** A device consisting of a small cylinder and piston, the piston being free to move against the resistance of air or a liquid such as glycerine, this serving to damp its movement and prevent vibration. Used on governors, valves of Corliss engines, etc.

**Dead-beat,** Modern ammeters and voltmeters are dead-beat, in that the needle rises quickly to the value of the current or voltage passing and stops, instead of oscillating back and forth across this point the movement is damped. In a watch, a dead-beat escapement.

**Dead Turns,** Those parts of the winding of an armature which are outside of the magnetic field and do not contribute to the e. m. f. it produces. In modern forms of winding, dead turns have been practically eliminated.

**Decomposition, Electrolytic,** The separation of a liquid into its constituent gases, as by passing a current through it using platinum electrodes, water may be decomposed into volumes of hydrogen and one of oxygen. Chemical symbol for water $H_2O$.

**Demagnetization,** Removal of magnetism from a magnetic substance, such as steel parts of a watch which has become magnetized through being brought too close to the magnetic field of a generator. Watch is usually rotated in a strong field produced by an open coil and while rotating gradually withdrawn from its influence of the strength of the field itself reduced to zero.

**Deposit, Electrolytic,** Metal deposited by a current, as in electroplating, the making of electrotypes for printing, etc.

**Dielectric,** The insulator of a condenser, air, glass, paraffined paper, mica, etc. Any insulating substance.

**Dielectric Constant,** A number expressing the relative capacity of an insulator to withstand potential strain as compared with air, which is the standard.

**Dielectric Strain,** The strain to which an insulator is subjected when its opposite surfaces are subjected to a potential. This strain is so great at high voltages that the plate glass dielectric of a condenser may be punctured, or large insulators broken.

**Differential Winding,** When it is desired to prevent an increase in voltage beyond a certain point regardless of the increase in speed, the series winding of a compound generator is connected so that the increased current passes through it in the opposite direction, thus tending to demagnetize the field of the generator. Also termed a Bucking Winding and used on the generators of wind-driven plants, automobile lighting generators and wherever there is a great variation in the speed of the generator.

**Dimmer,** A resistance which may be cut into the circuit carrying a lamp or lamps, to reduce the intensity of the light, as on automobile headlights.

**Discharge, Brush,** The escape of electricity at high potential from its conductor. Also termed Corona, Electric Glow, etc., sometimes visible at night on high-tension transmission lines and wireless antennae.

**Discharge, Disruptive,** A discharge of a heavy static charge of electricity through a dieletric. Lightning striking a barn or house is a disruptive discharge, the air being the dielectric. It is oscillatory in character, alternatng at high frequency.

**Distance, Sparking,** Space between electrodes, or distance of gap that will be bridged by a given voltage. Standard sparking distance of spark plug 1/32".

**Distributing Box,** Same as panel board, junction box, cut-out, etc., an insulating support on which a main circuit is subdivided into branch circuits through fuses and switches.

**Door Opener,** A spring lock or catch held in place by the armature of an electro-magnet. When current passes through the magnet, the armature is attracted, releasing the lock so that the door may be unlocked from a distant point.

**Double-throw Switch,** A switch that may be thrown to the left or right making contacts with two separate sets of clips to cut in either of the two circuits represented by the latter. Used for connecting a battery in series or parallel with the charging source, as in the case of a wind-power plant when the generator is not running fast enough to charge the battery in series.

**D. P. D. T. Switch,** A double-pole, double-throw switch.

**D. P. S. T. Switch,** A double-throw, single-pole switch.

**Double-Pole Switch,** One having a connection for each side, or pole, of the circuit.

**Drag,** Pull exercised by a magnetic field upon a conductor moving through it, or upon the motion of an armature in it.

**Drip Loop,** A small loop made in wires just before they enter a building so that rain will drip from the lowest part of the loop instead of following the wire into the building.

**Drop Automatic,** An electro-magnetic release designed to make or break a circuit, consisting of a latch held in place by the armature; when the latter is attracted by the passage of the current, the latch falls and either breaks a circuit, in which case it is a form of circuit-breaker, or closes another circuit to ring a bell, light a lamp, etc. Also known as a Constant Ringing Drop as bells continues to ring until latch is re-set by hand.

**Dynamo,** Short for "dynamo electric machine" and synonym for generator; the combination of a self-exciting field and rotating armature with a commutator which, when driven by an outside source of power, generates an electric current. This describes a D. C. generator. An A. C. generator consists of a stator, a rotor, collecting rings and brushes and an "exciter" which is a small D. C. generator directly connected to the fields of the A. C. generator to magnetize them, since they are not self-exciting as in the D. C. machine. See text for different types D. C. machines, series, shunt and compound.

**Dynamo, Electroplating,** A. D. C. machine designed to produce a very heavy current at low voltage, as 1,500 amperes at 6 volts, which is the highest potential used in plating, some operations being carried out with current at 4 volts.

**Dynamotor,** A double wound machine with two commutators, one side being employed as a motor and the other as a generator; used for raising the voltage of a D. C. current, also as a starting and lighting unit on automobiles. The term is also applied to the single commutator, compound wound automobile unit alternately used as starting motor and generator for battery charging.

**Earth, Earth connection, Earth return,** Synonyms for ground connection or return.

**Efficiency,** Percentage the output of a machine or device bears to the amount of power absorbed by it in producing that output. The commercial efficiency of a storage battery is approximately 80 per cent., so that out of 100 ampere hours of charge, it will deliver 80. The thermal, or heat, efficiency of the gasoline engine is 25 to

28 per cent., the remaining 75 to 78 per cent. of the heat value of the fuel being lost in the water jacket or other means of cooling (about 45 per cent.) and the balance passing out through the exhaust. But the mechanical efficiency of the same engine may run as high as 85 per cent., which means that considering the power produced by the explosions as 100 per cent. but 15 per cent. is lost in overcoming the friction of the engine itself. The efficiency of the modern generator reaches 85 to 95.

**Ediswan,** Abbreviation for Edison Swan, a type of lamp base with flat contacts and a bayonet lock instead of a screw thread. Used abroad and on auto lamps since it does not shake loose under vibration.

**Electricity,** One of nature's powers, often termed the electric fluid, which when in disturbed equilibrium (acting under a difference of potential, or voltage) flows which a circuit movement, this movement involving polarity, or opposition of properties in opposite directions: which exhibits itself by an attraction for many substances, also by an attraction of points or surfaces of unlike polarity and repulsion between those of like, by accumulated tension when the circuit is broken and by the production of heat and light when passed through a resistance, or chemical change when passed through a liquid—Webster. Just what electricity is has never been satisfactorily defined; it is identical with or the counterpart of magnetism since the two are interchangeable, as one may be produced from the other. It is thought that the light and heat from the sun reach the earth as electro-magnetic waves which are converted into light and heat by the earth's atmosphere, there being no heat in the space above our atmosphere.

**Electrics,** An obsolete term for substances which became electrified when rubbed. This is true of many substances when insulated, as a piece of copper insulated by a glass, or a hard rubber handle, may be electrified by friction.

**Electrification,** The receiving or imparting of an electric charge to a surface or body; said of electrostatic phenomena, see above.

**Electrodes,** Terminals of a circuit between which current passes, as the carbons of an old style arc lamp; elements of a battery, the positive being termed the anode and the negative, the cathode.

**Electro-dynamics,** Laws governing electricity in motion, as opposed to electrostatics, those governing an electrical charge at rest, as in a condenser or on a charged, or electrified body.

**Electro-dynamometer,** A device for measuring the strength of a current by the reaction between two coils; the principle on which the earliest form of a meter is based.

**Electrolier,** An electric fixture or chandelier.

**Electrolier Switch,** Two-circuit or three-circuit switch used in controlling separate lamps or separate groups of lamps in an electric fixture.

**Electrolysis,** Separation of a solution or a substance into its elements by the passage of an electric current. See Decomposition Electrolytic. Water and gas mains in city streets are attacked and dissolved by electrolysis due to leakage in the current from street railway circuits.

**Electrolyte,** Battery solution, distilled water and sulphuric acid; any body susceptible of decomposition by the electric current.

**Electro-magnet,** A winding, or coil, of wire on an iron core rendered magnetic by the passage of the current.

**Electro-magnetic Field of Force,** The magnetic field set up by the flow of a current; every conductor carrying a current is surrounded by concentric lines of force having the conductor as their center.

**Electro-magnetic Induction,** When a coil carrying a current is brought close to one in which there is none, a current is induced in the latter, this effect being greatly increased by placing a soft iron core in the first coil. In order that induction may take place, the circuit of the first coil must be made and broken, or the current in it increased and decreased as in A. C. The principle upon which the induction coil and transformer are based.

**Electro-magnetic Lines of Force,** See above and illustrations in text.

**Electro-magnetic Theory of Light,** See Electricity.

**Electro-metallurgy,** Science of reduction of ores by electrical processes. Extensively used in production of aluminum; also of certain grades of steel in electric furnaces.

**Electro-motive Force,** The difference of potential or voltage that causes the flow of a current. Mechanical equivalent, pressure causing flow of water. See also Counter E. M. F.

**Electroplating,** Deposition of metals by electrolysis.

**Electro-pneumatic Signals,** Railway signals, released by electromagnets operated by compressed air. Same principle is applied to operation of doors of subway trains.

**Electrostatic Attraction and Repulsion,** Attraction and repulsion electrically charged bodies have for each other, similar to magnetic attraction and repulsion.

**Element, Heating,** The resistance used in electric irons, toasters, percolators and other heating devices. See Coil, Heating.

**Entrance Switch,** A double-pole switch used where a main circuit enters a panel box, or cut-out.

**Exciter,** A small D. C. generator used to magnetize the fields of an alternator.

**Explorer,** A small coil used to investigate the field of a magnet or an electro-magnetic circuit.

**Farad,** Practical unit of electric capacity, the capacity of a conductor which can retain one coulomb of electricity at a potential of one volt. (An ampere is equivalent to a current flow of one coulomb per second, the coulomb being the laboratory or theoretical and not the practical unit of measurement, which is the ampere.) The Farad is used in the measurement of the capacity of condensers, such as used in ignition systems, but it is such a large unit, that it is usually divided into millionths, termed micro-farads. From Faraday, an early electrical investigator of note.

**Externally Operated Switch,** A switch enclosed in a metal box with a protruding handle so that the switch may be operated without opening the box. (An ampere is

**Fahrenheit Scale,** The thermometer scale in use in the U. S. and England and in which the temperature of melting ice is 32°, termed freezing, and that of condensing steam 212°, termed boiling. All degrees of equal length. To convert into Centigrade (French and Continental thermometer scale), substract 32 and multiply by 5/9; to convert C. into F. multiply by 9/5 and add 32.

**Farm Light and Power Plant,** Any combination of an electric generator and a means of driving it, whether by gas or oil engine, wind or water power, with or without a storage battery for supplying lights and power and ranging in capacity from about 750 watts to 25 KW or more. Anything below 750 watts would be a Farm Light Plant, not being capable of furnishing sufficient power to merit that term unless supplied with a large battery and the engine kept running a substantial part of the time to keep it charged, which is not usually the case.

While termed Farm Light and Power Plants owing to the great number in use on farms and for want of a better name, they are serving a multitude of uses. Technically, they are Isolated Electric Plants and are made in a number of types, belted and direct-connected, which call for no explanation, Full Automatic, Semi-Automatic and Hand Controlled, as explained below.

**Full Automatic,** A plant that starts and stops itself without other attention than that necessary to keep it supplied with fuel, oil and water. There are two types of full automatic plants, first, those that start automatically whenever any part of their circuits close, as by turning on a lamp, cutting in of an automatically controlled motor, etc. When all of the circuits connected to the plant are opened, it stops automatically. The only storage battery used is for cranking the engine to start.

**Second,** Full Automatic with a reserve battery, starting automatically whenever the battery discharges to a certain point and stopping when the battery is fully charged; also one that will start automatically by means of an overload relay whenever the load upon the battery discharges it at too rapid a rate, the generator then furnishing all the current required directly and storing the surplus in the battery. Automatic plants of this type are also equipped with the so-called heat, or emergency switch, which limits the time during which the battery is permitted to crank the engine in case of failure of the latter to start, as through lack of fuel, faulty ignition or the like At the end of a minute or two, this time limit relay, automatically opens the starting circuit.

**Semi-Automatic Plant,** One which is started by hand but is provided with a device to stop it when the batteries are fully charged, in addition to the usual automatic cut-out, or reverse current relay designed to protect the storage battery.

**Hand-Controlled Plant,** One that is started and stopped by hand, the only automatic device being the cut-out mentioned above.

**Faults,** Sources of loss, increased resistance or other trouble in a circuit.

**Feeder,** A main circuit supplying a district. The main circuit from the plant or battery to the house where it is divided into branch circuits, may be termed a feeder.

**Fibre,** An insulating material, usually given various trade names, such as Vulcanite, etc.

**Field,** Magnetic field, Interchangeably used to indicate a magnetic field or the electro-magnets producing it, as the field of a generator.

**Field Density,** Number of lines of force per unit area of cross section perpendicular to the lines of force in a magnetic field. Factor used in the design of generators and motors.

**Field Distortion,** Bending of the lines of force of a magnetic field through a moving member, as a generator armature.

**Filament,** Fine metallic wire forming the light-producing element of a lamp.

**Fire Alarm,** See Alarm.

**Fire Alarm Telegraph,** A system of alarm boxes and lines centering in a fire station. Each alarm box is provided with a spring rotated disc carrying certain combinations of notches. When the disc is rotated by pulling a handle and releasing it, contacts corresponding to the notches are made, closing a circuit which rings a bell in the station giving the location by numbers of the alarm box.

**Fire Extinguisher,** Device for putting out fires quickly at the start. Two types commonly employed, one made in 3- and 5-gal. sizes containing a solution of bicarbonate of soda in a copper container and a half pint of sulphuric acid in a bottle. Inverting the container empties the acid into the soda solution and creates a high pressure. A smaller type containing a quart of tetrachloride of carbon in a copper cylinder fitted with a piston for pumping the liquid directly on a fire, or a pump that raises air pressure and ejects the liquid. Both form heavy volumes of carbonic acid in contact with the flame and blanket the fire.

**Flashing,** Excessive sparking at the brushes of a generator or motor.

**Flashing Over,** Sparking carried around the commutator.

**Flexible Conduit,** A flexible type of conduit for running wires in concealed wiring and that may be run around corners or bends without the use of a pipe bender as in iron pipe conduit.

**Flip Switch,** A form of snap switch having a small lever instead of a key.

**Flux,** Flow of current or magnetism. A paste, powder or liquid used in soldering and in welding.

**Floor Push,** Push button designed to be set flush in the floor with the button protruding slightly so as to be pushed with the foot.

**Flush Receptacle,** One designed to be set flush with a wall or floor.

**Foamite-Fire Foam,** A patented chemical solution used in fire extinguishers and especially valuable for oil and electrical fires. Water should never be used under any circumstances on burning grease, oil or an electric arc.

**Foot-candle,** Unit of illuminating power; light given by a standard candle at distance of one foot.

**Foot-pound,** Unit of work or energy. A horsepower equals 33,000 foot pounds, or a weight of 33,000 lbs. raised one foot per minute.

**Four Cycle,** Literally, four-part-cycle, a type of gasoline engine. See cycle.

**Franklin's Experiment,** Proof of identity of lighting and electricity by flying a kite in a thunder storm, the string acting as a conductor when wet. A key was attached to the lower end of the string and a length of silk to insulate it. Sparks were drawn from the key.

**Frame,** Support of the pole pieces of a generator or motor.

**Frictional Electricity,** Static electricity produced by rubbing a substance. See "Electrics."

**Furnace Electric,** Heat is produced by the formation of an arc between heavy carbon electrodes. Used in reduction of aluminum and for making certain grades of steel.

**Fuse,** A piece, or link of fusible metal introduced in a circuit to protect the apparatus in it in case of an overload. The metal is an alloy of lead and antimony and melts at a low temperature. Protected by a plug or cartridge container to prevent the blow out and molten metal setting fire to adjacent objects.

**Fuse Board, Box,** See Panel board, junction box, cut-out, etc. An insulating support for fuses.

**Galvanizing,** Coating iron or steel, previously cleaned by pickling with hot acid solution, with molten zinc to prevent rusting.

**Galvanometer,** A highly sensitive ammeter used for laboratory measurements.

**Gassing,** Evolution of gas from the electrolyte of a storage battery in charging, indicating that more current is being sent into the battery that it can absorb. When a battery gases actively, particularly when the cells are not yet fully charged, the current strength should be reduced immediately to prevent overheating.

**Generator,** See Dynamo.

**German Silver,** An alloy of copper, nickel and zinc having a high resistance.

**Gimbals,** Equalizing mounting of a compass to permit it to remain level at all times.

**Gram,** Unit of weight in the metric system, 1/1000 of a kilogram, equivalent to 2.2 pounds. 1 gram equals 15.4 grains.

**Graphite,** A form of carbon occurring in nature, also made artificially. Used for making carbon brushes and as a lubricant, as a base for paint, etc.

**Gravity,** Attraction of bodies toward the center of the earth in proportion to their weight, equal to the earth's attraction, minus the centrifugal force set up by the earth's rotation on its axis.

**Gravity,** Acceleration of, Velocity imparted to a body in falling by gravity, approximately 32.2 ft. per second at sea level; varies in different parts of the globe.

**Grid,** Perforated or ridged plate of lead into which an oxide of lead is forced under heavy pressure to make storage battery plates.

**Ground,** Contact of part of a circuit with the earth, or equivalent, as a water pipe, and through which the current returns without reaching that part of the circuit beyond the ground.

**Ground Clamp,** Copper strip, provided at one end with lug connection for wire, and at the other with holes through which the clamping screw may be passed.

**Growler,** An electro-magnet with tapered poles to receive a small armature. Used with A. C. to detect shorts and grounds in armature windings. When a faulty armature is placed on the instrument and the current passed, a distinctly audible noise is produced.

**Gutta Percha,** Another name for rubber used as insulation.

**H,** Symbol of intensity of magnetizing force of a field.

**Heat,** A form of energy measured in thermal units; B. T. U. (British thermal unit); C, calbrie (French). It is transmitted by conduction through a solid body and by convection through air or gases. Calorimeter, a heat-measuring instrument. The B. T. U. is the amount of heat required to raise one pound of water from 32 to 33° F.

**Heat Switch,** One operated by the heat of the current passing through a resistance element which causes the switch to open the circuit after a certain time. Designed to protect the starting battery of an automatic plant. See "Emergency Stop."

**Heliograph,** A device for reflecting a beam of light, with a shutter to cut it off at will; used in visual signaling.

**Helix,** A coil of wire without a core; technically, a coil wound to follow the outline of a screw thread without overlaying itself.

**Henry,** Unit of electro-magnetic inductance, approximately equal to one quadrant of the earth measured on the meridian. Practical unit is the micro-henry, or one millionth henry.

**Hermetically Sealed,** Closed absolutely tight against the admission of air, as in an incandescent bulb, after exhausting all the air by means of a vacuum pump, the glass is melted together to seal it.

**Hickey,** A double-threaded pipe fitting used for attaching fixtures to the wall or ceiling.

**Hickey, Pipe-Bending,** A device for bending soft iron pipe or conduit used in wiring.

**High Bars,** Segments of a commutator that project above those adjacent to them as the result of wear or excessive sparking at certain points. Remedied by turning the commutator down in a lathe.

**High Frequency,** An A. C. of more than the usual standard frequency, or 60 cycles per second, is usually termed a high frequency current. Frequencies of from 500 to 100,000 cycles are used in wireless transmission.

**Horsepower,** Unit of work, 33,000 lb. lifted one foot per minute, or its equivalent.

**Horsepower, Electric,** 746 watts are taken as the equivalent of one mechanical horsepower, given above.

**Horsepower Indicated,** The amount of power an engine working at a certain speed and pressure should develop. Symbol, I. H. P.

**Hydro-electric Plant,** One driven by water power.

**Hydrogen,** An element existing as a gas under all except the most extreme conditions of cold and pressure. Hydrogen gas is evolved from the electrolyte of the storage battery under charge. Highly inflammable and when mixed in certain proportions with air, or oxygen, very explosive. An open light should never be brought near a storage battery.

**Hygrometer,** An instrument for measuring the amount of moisture in the air.

**Hysteresis,** A phenomenon of magnetization in iron, considered to be a form of internal or molecular friction in the metal.

**Igniter,** Device for causing a spark to occur in the cylinder of a gasoline engine using low tension ignition, usually termed a make-and-break igniter, since it closes, or makes, the circuit and is then tripped to break it, causing a small arc between the electrodes.

**Illuminating Power, Spherical,** The average illuminating power determined by photometric test, in all directions from the source of light.

**Impedance,** The sum of all factors opposing the passage of a current. With D. C., it is equivalent to the resistance, but in A. C. it is the resistance, plus inductance and other factors.

**Incandescent Lamp,** One in which the size of the filament is such that the passage of current at a certain voltage will bring it to a white heat, or incandescence.

**Indicating Switch,** One showing whether it is "ON" or "OFF." Snap switches controlling distant lights or motors should be of this type.

**Inductance,** Self-induction; that property of a circuit by reason of which it produces induction and develops lines of force. Coils used in wireless telegraph apparatus are termed inductances.

**Induction, Electro-magnetic,** The interaction of electro-magnetic lines of force in adjacent circuits or coils, resulting in the prodution of an induced current, as in the ignition coil.

**Induction, Mutual,** Induction due to two currents reacting on each other.

**Induction, Self,** The equivalent of mechanical inertia in an electric current. Water flowing in a pipe resists a sudden change and the quick closing of a valve results in "water hammer." So when a current flowing through a coil having an iron core, is suddenly shut off, the current may be said to "pile" in the same manner as water. The magnetism of the core is returned to the circuit as additional current so that the spark, or arc, produced at the break has a greater value than that of the line current itself. The single wound coil used with make-and-break ignition has a high self-induction and increases the size of the spark at the igniter.

**Insulator,** Any insulating substance, glass, rubber, cotton, silk, fibre, etc.

**Insulator Canopy,** A fibre strip placed over edge of fixture canopy to insulate it from a metal ceiling.

**Intensity,** Strength of a current or a magnetic field.

**Interrupter,** A circuit-breaker.

**Joule,** Laboratory unit of electric energy, a volt-ampere represents one joule per second.

**Junction Box,** Same as panel box, distributing box, cut-out, etc.

**Keeper,** See armature.

**Key,** A switch for making and breaking a current, as a telegraph key.

**Keyless Socket,** One without a key for turning the current on and off at the socket.

**Kilowatt,** One thousand watts. Electric current is charged for in kilowatt hours, a KW hour being the equivalent of the use of 1,000 watts for one hour.

**Kilogram,** Unit of weight of the metric system, 2.2 lbs.

**Knife Switch,** One having its connecting element in the form of a thin bar, made in single and double pole, and angle and double throw types.

**Knob,** Single wire porcelain insulator for open wiring.

**Knot,** The geographical mile, 6,087 feet.

**Lacquer,** Transparent shellac used in protecting the finish of fixtures.

**Laminated,** Made up of thin plates, or laminations, as the armature core of a generator, or of a transformer.

**Lamp, Pilot,** An incandescent lamp formerly mounted on the switchboard of a generator to show when the latter "built up" its magnetic field. Pilot lamps are now sometimes used in connection with electric irons or other heating devices to indicate that the current is on.

**Lead-in Wires,** The fine wires passing through the glass of an incandescent bulb to connect with the filament. Lead-in wire passing through the wall of a house from a wireless antennae to the receiving instruments.

**Leyden Jar,** A form of condenser, consisting of a glass jar the sides of which are coated inside and out to a certain height with tinfoil. A rod and chain passed through the cork form connection with the inside coating.

**Leakage,** Loss of current through poor insulation or grounding at parts of the circuit. The leakage in wet weather from bare wire lines such as telegraph and high-tension A. C. lines is often heavy.

**Life of Incandescent Lamp,** Time during which an incandescent lamp will serve before the filament breaks; the filament volatilizes (is converted into gas by the heat) and becomes very thin. The life of the lamp depends to a large extent on the voltage at which it is burned; if below that at which it is rated, it will be increased, if above, decreased.

**Lightning,** Equalization of potential between clouds, or between a cloud and the earth, in the form of a heavy electrostatic discharge. The flash is often over a mile long and is estimated to represent a small amount of current at a potential of 50,000,000 volts, or over. It takes place in three forms, sheet lightning, which appears as a glow in the clouds and is the equivalent of a brush discharge or corona; a zig-zag flash, which is the disruptive discharge that causes so much damage wherever it strikes, and globe or ball lightning, sometimes visible for ten to twenty seconds. These so-called fire balls frequently disappear silently and at other times explode, causing terrible havoc.

**Lightning Arrester,** A device used on telegraph, telephone and high-tension lines to lead lightning discharges picked up by these lines into the ground. Usually consists of a gap the sides of which are toothed or notched to encourage a discharge through the points, one member of the gap being grounded.

**Lightning Rod,** A pointed copper or other metal rod projecting several feet above the roof of a building to attract lightning discharges and lead them into the ground. To protect buildings effectively, a number of rods are used on the most elevated parts of the roofs, all being connected together and to a ground connection which must be carried deep enough into the earth to insure its being in contact with moist soil at all times.

**Lines of Force,** Imaginary lines indicating the direction of attraction and repulsion in a field of force: electro-magnetic, electrostatic, magnetic lines of force.

**Links, Fuse,** The soft metal fusible element of a safety fuse.

**Listening Cam,** The cam switch on the telephone operator's switchboard by means of which the operator's head phone is cut in on the subscriber's line.

**Local Action,** Electrolytic action which takes place between the electrodes of a primary battery regardless of the outer circuit. Takes place in a storage battery that is left uncharged for long periods.

**Local Battery,** The battery at a telegraph station, which is cut into the circuit by a relay on messages passing through that station and intended for one further distant.

**Lodestone,** Magnetite, a form of iron ore which is naturally magnetic and from which the term "magnet" is derived.

**Lug,** Terminal connection for large wire; wire is soldered into one end of lug; other end of lug is made in washer shape to slip over binding post.

**Magnet,** A body having the power to attract iron or steel and which, when suspended by its center of gravity so that it is free to turn, will move to an approximately north and south pointing position and remain there unless influenced by another magnet or piece of magnetic metal near it. Bar magnet, horseshoe magnet, etc., are forms of permanent magnets made of hard steel which retains its magnetism. See "Electro-magnet."

**Magnet Coil,** See Electro-magnet. Winding of an armature or field.

**Magnet Core,** The soft iron or laminated core of an electro-magnet. See Armature Core.

**Magnet Field,** The electro-magnet used on the field of a generator or motor.

**Magnetic Adherence,** Holding power of a magnet for a piece of iron due to shortening of the lines of force, iron being a much better path for magnetism than air.

**Magnetic Attraction and Repulsion,** Unlike poles of magnets, that is, a N and S pole attract one another; like poles repel.

**Magnetic Battery,** A number of permanent magnets clamped together or to pole pieces, as in the magneto used for ignition.

**Magnetic Circuit,** The lines of force of a magnet are approximately parallel but bend around in a circle. Thus in a horseshoe magnet, the magnetic lines of force issue from the N pole and curve through the air to return to the magnet at the S pole, completing the magnetic circuit. By placing an armature, or keeper, on the poles, the magnetic circuit is shortened.

**Magnetic Density,** Intensity of magnetization expressed in the number of lines of force per square inch of area of cross section at right angles to the lines themselves.

**Magnetic Elongation,** When magnetized a bar of iron or steel becomes slightly longer as determined by high precision measurements in the laboratory. There is no perceptible change though a faint sound may be heard.

**Magnetic Flux,** The flow of lines of force in a magnetic field or circuit.

**Magnetic Inertia,** Similar to self-induction in an electric circuit. An appreciable period of time is necessary to cause an iron core to become saturated, that is, take all the magnetism it can hold. Termed magnetic lag. When magnetized, it also resists demagnetization and does not give it up entirely, that remaining being termed Residual Magnetism.

**Magnetic Insulation,** Brass, copper, zinc, aluminum and tin are non-magnetic metals; all insulators are also non-magnetic and any of these substances when placed before a magnet act as a magnetic shield, but do not entirely prevent the passage of the magnetic lines of force. There is no perfect magnetic insulator. Soft iron is the most permeable to magnetism; the best magnetic insulator is 10,000 times less permeable than iron.

**Magnetic Leakage,** Not all of the lines of force from a magnet pass through its armature; some escape into the air. This is termed magnetic leakage and must be allowed for in the design of generators and motors since all of the magnetic field produced by a magnetic field cannot be utilized. In certain forms of A. C. transformers, magnetic leakage is intentionally provided, a gap being left in the core for this purpose.

**Magnetic Permeability,** See Magnetic Insulation.

**Magnetic Poles,** The north and south poles of the globe, also the same poles of any magnet.

**Magnetic Reluctance,** See Magnetic Inertia.

**Magnetic Saturation,** See Magnetic Inertia.

**Magnetic Separator,** A device for separating magnetic from non-magnetic metals, also to remove pieces of iron from grain in flour mills and from clay in porcelain works, usually consisting of a battery of permanent magnets placed in the bottom and sides of a conveyor through which the material passes.

**Magneto,** A small A. C. generator used to produce a current for ignition, also for calling in the old type hand-ringing telephone, so termed because its field is formed of a battery of permanent magnets.

**Mains, Electric,** Chief circuits of an installation as compared with branch circuits.

**Make-and-break Current,** See Igniter.

**Matting, Electric,** See Alarm.

**Metal Moulding,** Metal duct for carrying circuit wiring; consists of "backing" which is screwed to surface on which wiring is to be done, and "capping," the covering which is snapped on to the backing.

**Meter,** A device for measuring the amount of current passing through the circuit on which it is placed. Modern electric meters are direct reading, that is, they indicate directly the actual consumption usually in KW hours. This is a Wattmeter.
**Mica,** A mineral largely used as an insulator and as a dielectric.
**Micro-,** Prefix meaning one-millionth part of, as a Micro-farad is one millionth of a farad.
**Micrometer,** An instrument for measuring very small distances or objects, down to the 1/1000 or the 1/10,000th part of an inch.
**Microphone,** An extra sensitive telephone transmitter, used in wireless telephony.
**Mil, Circular,** A unit of area employed in designating the cross sectional area of wires.
**Milli,** Prefix meaning one-thousandth part of, as a milli-ampere.
**Millimeter,** Metric unit of length, representing one thousandth of a meter, which is approximately 39.3 inches. There are 25.4 millimeters in an inch.
**Miniature,** Term applied to small bases, receptacles, lamps, etc., used for decorative purposes. There are three sizes of fittings in general use, standard, candelabra and miniature.
**Molding,** A two-piece support for wiring having two channels in the base for the wires and a cap to cover them; made in wood and metal.
**Motor, Electric,** A machine designed to convert electrical into mechanical energy. The D. C. motor is essentially the same as the dynamo and is made in the same types, series, shunt and compound, also differentially wound in which the series and shunt windings oppose each other.
**Motor-generator,** A combined motor and generator, consisting of two units with their armatures on the same shaft. The motor is usually A. C. and the generator D. C., used to convert A. C. to D. C. where only a small amount of current is needed. See Converter, Rotary.
**Multiple, Synonym for Parallel,** A method of connecting devices in circuit, as lamps are connected in multiple. A circuit on which every device draws an amount of current in proportion to its resistance and at the same voltage.
**Multiple-Series,** A combination of a series with a multiple, or parallel, circuit.
**N,** Symbol for north and the north-seeking pole of a magnet.
**Negative Element or Plate,** The negative electrode of a battery to which the current is supposed to return after flowing through the remainder of the circuit.
**Neutral Line of Commutator,** The diameter of a commutator running through its neutral points at which the brushes are placed.
**Neutral Wire,** The central wire of a three-wire system of distribution fed by two 110 v. generators in series, so that 110 v. current may be drawn from a circuit composed of the center and either outside wire, and 220 v. current from the two outside wires.
**Nipple,** A piece of pipe threaded on both ends, used in fixture work and in water piping, iron pipe conduit, etc. Nipples are "close" or all threads; "short," with two to three inches of pipe between the threads, and "long," about six inches overall.
**Nitrogen Lamp,** One in which nitrogen gas fills the space surrounding the filament, instead of a vacuum.
**Non-conductor,** Any insulating material. Insulator, Dielectric.
**North Pole,** The north-seeking pole of a magnet, or its equivalent in an electro-magnet.
**Ohm,** The practical unit of resistance. The legal ohm is the resistance of a column of mercury 1 sq. millimetre in cross section and 106 centimeters long, at 32° F.
**Ohmic Resistance,** True resistance as distinguished from counter e. m. f.
**Ohmmeter,** An instrument for giving the resistance of a circuit in direct reading.
**Ohm's Law,** The fundamental law expressing the relation between current, voltage and resistance. See Text.
**Open,** Said of a circuit when there is any break in it, as of an open switch or a blown fuse so that no current passes.
**Outlet,** In concealed wiring, a metal box or similar device through which wires are led for the connection of a lamp or other appliance.
**Output,** The amount of energy that a generator is capable of producing.
**Output, Unit of,** The kilowatt, or 1,000 watts.
**Ovalduct,** Trade name for a type of metal moulding in which the "backing" and "capping" are incorporated in one seamless strip. Wires are fished through Ovalduct as in the case of rigid conduit.
**Over-compounding,** A proportioning of the series and shunt windings of a compound generator so that the voltage rises with the output. An increase in the ampere turns of the series winding.
**Overload,** An output in excess of the normal rating of a generator, or of the amount of power for which a motor is designed. A number of appliances connected in a circuit in excess of the amperage it is designed to carry is an overload and will blow the fuses.
**Ozone,** A form of oxygen produced by an electric discharge, the exhilarating effect of which is sometimes very noticeable after a heavy thunder shower.
**Paraffine,** A derivative of petroleum used for insulation of condensers and induction coils. In the latter, paraffine wax is melted and poured about the coils, filling the container.

**Parallel,** A form of circuit connection. See Multiple.
**Pendant, Synonym Drop,** A piece of flexible cord led from an outlet in concealed wiring, or a rosette in open wiring, for a lamp.
**Photometer,** An instrument used for measuring the intensity of light.
**Pickle,** An acid solution, usually heated, for cleaning metal surfaces before electro-plating or galvanizing.
**Plate, Synonym Grid,** The element of a storage battery, either positive or negative.
**Plate, Ground,** The plate of a lightning arrester connected to the ground.
**Plug,** A two-wire terminal for making connection with a receptacle or socket.
**Plumbago,** Soft graphite, used in powdered form to render objects conducting for electro-plating.
**Plunger,** The armature of a solenoid electro-magnet.
**Polarity,** Direction of current flow in a circuit, as indicated by plus and minus signs on its terminals.
**Polar Extension,** A piece added to the pole of a magnet, as in the field magnet of a generator, to extend its magnetic circuit over a larger area of the armature.
**Poles,** Terminals of an electric or of a magnetic circuit.
**Portable,** Any lamp or lighting fixture which may be moved about as far as its flexible cord connection will permit.
**Potential,** Voltage, or pressure in an electric circuit. The flow of a current is due to a difference of potential between two points.
**Primary,** The winding of an induction coil or transformer through which current is sent.
**Primary Cell,** A voltaic cell in which current is produced by the chemical consumption of one of the electrodes and the electrolyte. The dry cell is the only form of primary cell now in general use outside of telegraphy in which the gravity or Daniel (copper-zinc couple) is used.
**Pyrometer,** An instrument for measuring high temperatures by the variation in electric resistance of a platinum wire.
**Q,** Symbol of electric quantity.
**R,** Symbol of resistance. See Ohm's Law.
**Receptacles, Cleat,** Receptacles for use with open wiring on knobs or cleats.
**Register, Electric,** Used in connection with watchmen's check systems to show when each station has been visited during the night. Operated usually by the insertion of a special key.
**Regulation,** Early forms of dynamos such as the constant current machine used for arc lighting required a special device to maintain the current constant with a change in the resistance of the external circuit. Dynamos used on farm light and power plants are designed to be self-regulating and are of the constant potential type.
**Relay,** A telegraph instrument carrying a double set of contacts so that its movement by the line current cuts in the local battery. Also the automatic cut-out which is often termed a reverse current relay that prevents the storage battery sending its current through the generator when the latter's voltage drops.
**Reluctance,** The resistance offered to the flow of the lines of force in a magnetic circuit.
**Resistance,** The characteristic of any conductor that causes it to oppose the passage of a current, converting part of the energy represented by the latter into heat. Resistance varies directly as the length of the conductor and inversely as the cross section. It also varies widely in different substances and in metals increases with a rise in temperature. The term Resistance is also used to indicate any conductor or portion of a circuit expressly designed to develop resistance.
**Resistance Box,** See Box Starting. Also a set of resistances that may be used singly or in combination for testing purposes.
**Resistance, Carbon,** One in which the resistance elements are of carbon rods. Cast iron is also commonly employed.
**Resistance, External,** In a circuit, the resistance outside of the battery or generator.
**Resistance, Inductive,** A resistance in which self-induction is a factor. All electro-magnets possess inductive resistance due to their iron cores.
**Resistance, Internal,** That of the windings of a generator or motor, or the elements and electrolyte of a battery.
**Resistance, Ohmic,** The true resistance of a circuit, or device, expressed in ohms, as distinguished from counter e. m. f.
**Retentivity,** The force by means of which steel retains its magnetism.
**Rheostat,** An adjustable resistance. See Box, Starting.
**Rhumkorff Coil,** Same as induction coil.
**Riser,** Vertical conduit carrying mains up through a building.
**Rocker Arm,** Brush support in generators and motors.
**Rosettes, Cleat,** Fittings for use on open wiring from which drop cord may be suspended.
**Safety Fuse,** See Fuse.
**Saturated,** A solution is said to be saturated when the liquid can absorb no more of the salt, as a saturated solution of bicarbonate of soda is one in which soda has been added until it no longer dissolves.

**Selenium,** A metalloid that undergoes a change of resistance when subjected to light. Solenium Cell, a resistance box of selenium.

**Separately Excited Generator,** An A. C. generator using an exciter.

**Separator,** A perforated plate of wood or hard rubber placed between storage battery plates to insulate them.

**Series,** See Circuit, Series, also Series-Multiple and Series-Parallel.

**Service Wires,** Those leading from a street main or high-tension line (from a pole transformer) to a house.

**Serving,** Wrapping or winding a cable with small wire or heavy cord with a serving mallet, or block, as a protection.

**Shellac,** A vegetable resin dissolved in alcohol or other solvent, used as an insulator and dielectric.

**Shock, Electric,** The effect of the passage of a current at high voltage through the body. Its severity depends chiefly upon the potential difference, or voltage. For electrocutions, a current of about 8 amperes at 1,800 volts is used (New York State).

**Short Circuit,** A connection between the two sides of a circuit, short of the device or appliance the current is intended to reach and of lower resistance than the latter.

**Shunt,** A connection in parallel with a part of a circuit. A voltmeter is connected in shunt; shunt winding of the field of a generator or motor, the armature being in shunt, or parallel with the field.

**Sine Curve,** A curve representing the alternations of an A. C. current and equivalent to the curve a moving pendulum would make on a strip of paper being drawn slowly under it.

**Skin Effect,** High-tension A. C. and high frequency current does not penetrate but travels on its surface and this term is applied to this peculiarity.

**Snake,** A flat steel wire employed to draw wires through conduit under flooring and betweeen partitions.

**Solenoid,** A hollow electro-magnet either with or without a hollow iron core and in which a bar armature is drawn into or repelled by the passage of the current; used in electric governing devices, automatically operated resistance, etc.

**Spark Coil,** A coil having high self-induction consisting of a single winding of comparatively coarse wire, such as No. 18, on a heavy core of soft iron wire. Connected in series with a make-and-break igniter to intensify the spark when the contacts separate.

**Spark Gap,** Also termed safety gap, an opening of pre-determined distance in the external circuit of an induction coil or magneto (in shunt with the working circuit) to protect the windings in case the distance between the spark plug points is too great for the spark to jump, or the spark plug connection is removed and placed on an insulator. The current then jumps the safety gap.

**Sparking,** A discharge between the brushes and the commutator indicating the presence of dirt, insufficient spring pressure on the brushes, worn brushes, low bars, or if very bad, a shorted or grounded armature coil.

**Static Electricity,** A charge of electricity at rest as in a condenser, or other charged body. For many years it was considered to be of a different character than dynamic electricity, but the identity of the two has long been established.

**Step-down,** A transformer designed to reduce the voltage used in transmission to the service voltage. Step-up, reverse of above, as an induction coil which steps up the voltage to the high potential required for ignition.

**Storage Capacity,** The quantity of current expressed in ampere hours that a storage battery will deliver when fully charged.

**Strap,** Curved metal strip used to support conduit and armored cable.

**Sulphating,** The formation of hard white basic lead sulphate in storage cells that are discharged too far and in cells that are not given a long, slow charge at regular intervals, termed a seasoning charge. Failure to give this seasoning charge permits the sulphate to accumulate and decreases the capacity of the cells.

**Surface Leakage,** Leakage of current across the surface of insulating material due to the presence of moisture or metallic dust.

**S. W. G.,** Standard Wire Gauge; A. W. G., American Wire Gauge; B & S W. G., Browne & Sharpe Wire Gauge.

**Switch,** A device for opening and closing a circuit. See Double Pole Switch, sometimes termed a Double Break Switch.

**Switches,** The various types in common use are the Snap Switch, Flip Switch, usually single pole, the single and double pole knife switch and the automatic switch, of which the automatic cut-out is a type.

**Switches,** Three and Four Way, see text on House Wiring.

**Tape,** Two kinds are employed for insulating joints in wire, one of rubber and the other of rubber frictioned fabric making it adhesive.

**Tension,** Synonym for voltage or potential, as a high-tension current, one at a high voltage.

**Terminal,** End of any open electric circuit, also means of attachment for wires. Synonym, Binding Post.

**Thermo-electric Battery,** Certain metals, such as bismuth and antimony, when heated in conjunction with one another will produce a feeble current. Also termed Thermo-electric Couple, Junction and Pile.

**Thermometer, Electric,** One in which the temperature indications are due to changes in resistance of the conductors with a change in temperature. See Pyrometer.

**Thermostat, Electric,** A device similar to the electric thermometer designed for closing and opening an electric circuit with changes in temperature. Used to control the motor of small refrigerating or ice-making machines: when the temperature rises the thermostat closes the circuit and starts the motor, keeping it in operation until the temperature drops to the point for which the thermostat is set.

**Three-wire System,** See Neutral Wire.

**Throw,** Movement of a switch of the knife blade type. See Double Pole Switch.

**Thunder,** Noise produced by a disruptive discharge of lightning. The time elapsing between the flash and the sound gives a fairly close approximation to the distance of the discharge from the observer as when they occur together it is right overhead.

**Time Switch,** One controlled by a clock and designed to close or open one or more circuits at certain hours. Generally used in connection with store lighting, bill-boards, poultry houses, etc. See article on Lighting Poultry Houses.

**Time-rise,** The increase of voltage in a storage battery as charging proceeds, indicated on a graphic curve. See Curve, Characteristic. Time-fall, same on discharge.

**Thrust-bearing,** A bearing to take the end thrust or push of a shaft, as on vertically mounted generators driven by turbine water wheels.

**Throw-back Indicator,** An annunciator in which the drop is electrically replaced.

**Torque,** A force tending to produce torsion, or twisting, around an axis, often expressed as pounds pull at the end of a lever one foot long, or foot pounds. The starting torque of an electric motor.

**Transformer,** See Coil Induction.

**Transmitter,** Any instrument designed to produce signals in a circuit as a telegraph key, a telephone transmitter.

**Tubular Braid,** See Circular Loom.

**Unidirectional,** Synonym for continuous or direct, as applied to D. C.

**Unit, Circular,** A standard of measurement used for wire sizes. The unit is the circular mil equal to the area of a circle 1/1000 inch in diameter. Used in figuring load carrying capacity of wires. See Table of Wire Sizes and Equivalents.

**Vacuum,** Literally a space in which there is nothing, but in practice used to mean the absence of air. The filaments of incandescent lamps burn in a vacuum and the higher the vacuum the longer the life, since the presence of any oxygen would destroy them. In gas-filled lamps, the air is exhausted and replaced by a gas. See Nitrogen Lamp.

**Vapor Globe,** A glass globe placed about an incandescent lamp to prevent water or explosive gases reaching it. A lamp near a storage battery should have a vapor globe to prevent the hydrogen gas being set afire or exploded.

**Varnishes, Electric,** Those having an alcohol or ether solvent so that they dry quickly, do not absorb moisture and form good insulators.

**Velocity,** The rate of movement of a body expressed in distance traveled per second.

**Ventilation, Armature,** Spaces left in the armature and provision for sending air through them to prevent heating, a small fan sometimes being mounted on the armature shaft.

**Volt,** The practical unit of electrical pressure, potential or e.m.f. An e.m.f. of 1 volt will pass a current of 1 ampere through a resistance of 1 ohm.

**Voltage,** Potential or e.m.f. expressed in volts, as a voltage of 32 or 110 volts.

**Voltage, Terminal,** The potential difference, or voltage, at the terminals of a generator.

**Voltmeter,** An instrument for measuring the voltage in a circuit. It is wound to a high resistance compared to that of the circuit itself and is connected in shunt so that it takes very little current.

**Volt-coulomb,** The unit of electric work, equivalent to one watt per second.

**Vulcanite,** Hard rubber used for insulation.

**Waterproof Globe,** See Vapor Globe.

**Watt,** Practical unit of electric energy, or rate of work, equivalent to a current of one ampere at a potential of one volt; the volt-ampere. See Ohm's Law.

**Watt-hour,** One watt of electrical energy expended for one hour. See Kilowatt-hour.

**Whirl, Electric,** Term for the concentric, or circular, lines of force of the electro-magnetic field surrounding a conductor.

**Windage,** See Air Gap.

**Winding,** Wire forming the coil of any electro-magnet, characterized by the method of putting the wire on, as a drum (obsolete), lap, or wave-wound armature; or by the relation it bears to other parts of a machine, as a series, shunt, compound, over-compounded or differential winding. See explanation of these forms of winding below.

**Winding, Series,** This is the simplest form in which each brush has but one connection. All of the current generated in the armature passes through the field since the armature and field are in series.

**Winding, Shunt,** In this form each brush has two connections, one to the field and one to the external circuit. The field is wound to a higher resistance than the external circuit and is in shunt, multiple, or parallel with the armature, these three terms indicating the same form of connection. In accordance with Ohm's law the current divides in proportion to the resistance, so that when there is very little load on the machine, a correspondingly small amount of current flows through the shunt field winding. As the load (resistance) increases, more current flows through the shunt, making the field stronger so that the armature generates more current. The generator is accordingly termed self-regulating, but is only approximately so.

**Winding, Compound,** A combination of the shunt and series windings, one field winding being in shunt with the armature and the other in series. As the load increases, the voltage in the shunt winding increases while that in the series windings decreases, the windings being so proportioned that the effect is approximately equal and opposite, making the machine more closely self-regulating.

**Winding, Differential,** A type of compound winding in which the series coil is connected so as to produce magnetism of opposite polarity to that of the shunt winding to prevent a dangerous increase of voltage when the machine is run at a very high speed as on an automobile. Also termed a Bucking Winding.

**Winding, Lap,** A method of armature winding in which each lead of wire is lapped back toward the preceding lead on the commutator end of the armature.

**Winding, Shuttle,** A simple, continuous winding around the grooves of an H, or shuttle, armature, as used in magnetos for ignition.

**Winding, Wave,** A method of armature winding in which the commutator end of each lead is advanced progressively so that as many commutator segments intervene between any two consecutive commutator connections as there are leads on the armature between each two consecutive leads of wire. The principle of both lap and wave winding is to bring both sides of each loop, or U, of the winding through regions of opposite polarity in the magnetic field.

**Wire, Fixture,** No. 16 or No. 18 wire with rubber and cotton braid insulation. Insulation is not as thick as that in circuit wire.

# Trade Directory Section

## ADAPTERS, LAMP

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Acme Lighting Fixture Company, New York, N. Y. |
| "Adlake" | Adams & Westlake Company, Chicago, Ill. |
| | Beck & Company, A., New York, N. Y. |
| | Best Electric Company, New York, N. Y. |
| "Fittite" | Block & Company, L. D., New York, N. Y. |
| "Handy" | Chicago Electric Manufacturing Co., Ill. |
| | Hammer Company, E. A., Cleveland, Ohio. |
| | Hart & Hegeman Manufacturing Co., Hartford, Conn. |
| | Hubbell, Inc., Harvey, Bridgeport, Conn. |
| | Manhattan Electrical Supply Co., New York, N. Y. |
| "Mefco" | McFaddin & Company, H. G., New York, N. Y. |
| "Gil-Bo" | Metal Specialties Manufacturing Co., Chicago, Ill. |
| | Michon Manufacturing Company, Toledo, Ohio. |
| | Miller Company, E., Meriden, Conn. |
| "Tillery" | Miller Manufacturing Co., E. L., Kansas City, Mo. |
| | Morse, Frank, W., Boston, Mass. |
| "Curtis" | National X-Ray Reflector Co., Chicago, Ill. |
| "Diamond N," "Lenox," "Newport," "Tuxedo" | Noe & Sons, Wm. R., New York, N. Y. |
| | Peerless Light Company, Chicago, Ill. |
| | Plume & Atwood Manufacturing Co., Waterbury, Conn. |
| "Rosco" | Rosen & Company, A. W., New York, N. Y. |
| | Schedler Brothers Manufacturing Co., Phaladelphia, Pa. |
| | Smith Manufacturing Co., F. A., Rochester, N. Y. |
| "S-H" | Stuart-Howland Company, Boston, Mass. |
| "Anchor" | Timberlake & Sons, J. B., Jackson, Mich. |
| "Wilson" | Williams Manufacturing Company, Clarksburg, W. Va. |

## AMMETERS AND VOLTMETERS

| | |
|---|---|
| | Burton-Rogers Company, Boston, Mass. |
| "Milvay" | Chicago Apparatus Co., Chicago, Ill. |
| | Esterline-Angus Company, Indianapolis, Ind. |
| | General Electric Company, Schenectady, N. Y. |
| | Harvard Electric Co., Chicago, Ill. |
| | Hickok Electrical Instrument Co., Cleveland, Ohio |
| | Jewell Electrical Instrument Co., Chicago, Ill. |
| | Kermel Apparatus Company, Cambridge, Mass. |
| | Keystone Electrical Instrument Co., Philadelphia, Pa. |
| | Norton Electrical Instrument Co., Manchester, Conn. |
| | Pignolet Instrument Company, New York, N. Y. |
| | Queen-Gray Company, Philadelphia, Pa. |
| | Rawson Electrical Instrument Co., Cambridge, Mass. |
| | Reliance Instrument Co., Chicago, Ill. |
| "P. V.," "Imp." | Roller-Smith Company, New York, N. Y. |
| | **Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.** |
| | Weston Electrical Instrument Co., Newark, N. J. |

## AMPERE HOUR METERS

| | |
|---|---|
| "Chargometer" | Automatic Electrical Devices Co., Cincinnati, Ohio. |
| | Automatic Transportation Co., Buffalo, N. Y. |
| "Sangamo" | Sangamo Electric Co., Springfield, Ill. |

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Note: All lines are listed alphabetically in two sections and followed by a directory of wholesale electric supply houses from which all these lines can be bought. For lines not listed here write Farm Light and Power, 318 West 39th Street, New York, for **information.**

## ANNUNCIATORS

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Ansonia Electrical Company, Ansonia, Conn. |
| | Auth Electric Specialty Co., New York, N. Y. |
| | Connecticut Telephone & Electric Co., Meriden, Conn. |
| "Cotelco" | Couch Company, S. H., Norfolk Downs, Mass. |
| "Dixie," "Etonisl," "San-Fer-Ann," "Semaphore" | Edwards & Co., New York, N. Y. |
| | Holtzer-Cabot Electric Co., Boston, Mass. |
| | Knickerbocker Annunciator Co., New York, N. Y. |
| | Manhattan Electrical Supply Co., New York, N. Y. |
| | Obrien Mfg. Co., J. F., New York, N. Y. |
| | Ostrander & Company, W. R., New York, N. Y. |
| "Competition," "Guarantee," "King," "Presto" | Patrick & Wilkins Co., Philadelphia, Pa. |
| "Dandy," "Ross" | Samson Electric Company, Canton, Mass. |
| "De Veau," "Hygienic" | Stanley & Patterson, New York, N. Y. |

## AUTOMATIC CUT-OUTS

| | |
|---|---|
| | Automatic Electric Devices Co., Cincinnati, Ohio. |
| | Briggs & Stratton Company, Milwaukee, Wis. |
| | Carleton Company, Boston, Mass. |
| | Hartman Electric Manufacturing Company, Mansfield, Ohio. |
| | Jewell Electrical Instrument Company, Chicago, Ill. |
| | Palmer Electric & Manufacturing Co., Cambridge, Mass. |
| | Sangamo Electric Company, Springfield, Ill. |

## BATTERIES, DRY

| | |
|---|---|
| | American Carbon & Battery Co., East St. Louis, Ill. |
| "Ever Ready" | American Ever Ready Works of National Carbon Co., Long Island City, N. Y. |
| "Jove," "Mascot," "Standard" | Binnell & Co., J. H., New York, N. Y. |
| | Bright Star Battery Company, New York, N. Y. |
| "Super Six" | Burgess Star Battery Company, New York, N. Y. |
| "Add Water" | Burn-Boston Battery & Mfg. Works, Boston, Mass. |
| "Ace," "Victor" | Carbon Products Company, Lancaster, Ohio |
| "Twin Cell" | Champion Carbon Mfg. Co., Cincinnati, Ohio |
| | Chloride of Silver Dry Cell Co., Baltimore, Md. |
| (Flashlight) | Comet Battery Company, Cleveland, Ohio |
| | Delta Electric Company, Marion, Ind. |
| "Enco" | Enterprise Electric Novelty Co., New York, N. Y. |
| | Franco Electric Corporation, Brooklyn, N. Y. |
| "Fleur de Lis," "Ray-O-Spark" | French Battery & Carbon Co., Madison, Wis. |
| "Hi-Po" | Hi-Po Waterproof Battery Co., South Norwalk, Conn. |
| "Hipco" | Hipwell Mfg. Company, Pittsburgh, Pa. |
| "Three Star" | International Battery Co., New York, N. Y. |
| "Hi-up," "Mesco," "Red Seal" | Manhattan Elec. Supply Co., New York, N. Y. |
| "Acme Rapid Fire," "American," "Columbia," "Hot Shot," "Ignitor," "1900," "Red Label," "Reserve," | National Carbon Company, Cleveland, Ohio. |
| (Flashlight) | Niagara French Battery Company, Newark, N. J. |
| | Niagara Sales Corporation, New York, N. Y. |
| "Lustra" | Novo Mfg. Company, New York, N. Y. |
| (Flashlight) | Owl Flashlight Company, New York, N. Y. |
| "Sunray" | R. V. G. Company, Brooklyn, N. Y. |
| "Maxlife" | Stolp Company, Chicago, Ill. |
| "Matchless" | Sunlight Electrical Specialty Co., New York, N. Y. |
| "Old Master" | Toledo Battery Company, Toledo, Ohio. |
| "Kwik-Lite," (Flashlight) | Usona Mfg. Company, New York, N. Y. |
| | Victor Battery Company, New York, N. Y. |
| | Washington Automobile Supply Co., Washington, Ill. |
| "Red Shield" | Wesco Supply Company, St. Louis, Mo. |
| "Big Bear," "Bull Dog" | Western Dry Battery Company, Seattle, Wash. |
| "Helm" | Wilhelm, H., Broooklyn, N. Y. |
| | Williamson Electric Co., Brooklyn, N. Y. |
| (Flashlight) | Winchester Repeating Arms Co., New Haven, Conn. |

## BATTERIES, STORAGE

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Calumet Storage Battery Co., Chicago, Ill. |
| "Edison" | Edison Storage Battery Co., Orange, N. J. |
| **"Exide"** | **Electric Storage Battery Co., Philadelphia, Pa.** |
| **"Titan"** | **General Lead Batteries Co., Newark, N. J.** |
| "Globe" | Globe Electric Co., Milwaukee, Wis. |
| **"Gould"** | **Gould Storage Battery Co., 30 E. 42nd St., New York.** |
| | International Battery Co., Grand Rapids, Mich. |
| "High Power" | Mimimax Electric & Mfg. Co., Ltd., Montreal, Can. |
| "Multiple" | Multiple Storage Battery Co., Jamaica, L. I. |
| "Perfection" | Perfection Storage Battery Co., Chicago, Ill. |
| | Philadelphia Storage Battery Co., Philadelphia, Pa. |
| "Prest-O-Lite" | Prest-O-Lite Co., 30 E. 42nd St., New York. |
| "USL" | U. S. Light and Heat Corp., Niagara Falls, N. Y. |
| **"Universal"** | **Universal Battery Co., Chicago, Ill.** |
| | Wallace Lead Batteries Co., Louisville, Ky. |
| | Westinghouse Union Battery Co., Swissdale, Pa. |
| **"Willard"** | **Willard Storage Battery Co., Cleveland, O.** |

## BATTERY GAGES

| | |
|---|---|
| "Eveready" | American Ever Ready Wks. of National Carbon Co., Long Island City, N. Y. |
| | Ballman-Whitten Mfg. Co., St. Louis, Mo. |
| | Carleton Co., Boston, Mass. |
| | Connecticut Telephone & Electric Co., Meriden, Conn. |
| | Dow Mfg. Co., Braintree, Mass. |
| "Advance," Eclipse" | Eldredge Electric Mfg. Co., Springfield, Mass. |
| | Fore Electrical Mfg. Co., St. Louis, Mo. |
| "Genco" | General Scientific Equipment Co., Philadelphia, Pa. |
| | Harvard Electric Co., Chicago, Ill. |
| "Batometer" | Hempy-Cooper Mfg. Co., Kansas City, Mo. |
| "Ultimate," "Utility" | Hoyt Electrical Instrument Wks., Penacook, N. H. |
| | Jewell Electrical Instrument Co., Chicago, Ill. |
| | Loewus, E. H., 304 W. 54th St., New York. |
| "Mac" | Metric Appliance Corp., 299 Bway., New York. |
| | Nagel Electric Co., Toledo, Ohio. |
| "Cemeo," "Clark" | National Gage & Equipment Co., La Crosse, Wis. |
| "Prsco" | Pennsylvania Rubber & Supply Co., Cleveland, Ohio. |
| | Readrite Meter Works, Bluffton, Ohio. |
| "Handy," "P. V." | Roller-Smith Co., 9 Barclay St., New York. |
| | Sholder-Excel Mfg. Co., Clyde, Ohio. |
| | Standard Electric Mfg. Co., Newark, N. J. |
| "Trescot" | Sterling Mfg. Co., Cleveland, Ohio. |
| | Thompson Battery Tester Co., Greensburg, Pa. |
| | **Westinghouse Electric & Mfg. Co., Springfield, Mass.** |
| | Weston Electrical Instrument Co., Newark, N. J. |

## BEARINGS (Ball, Roller and Die Cast)

### Ball Bearings

| | |
|---|---|
| | Acorn Bearing Company, New Britain, Conn. |
| | Aetna Ball Bearing Mfg. Co., Chicago, Illinois. |
| "Allopar" | Alloy Parts Mfg. Company, Canton, Ohio |
| | American Ball Bearing Company, Providence, R. I. |
| | Auburn Ball Bearing Company, Rochester, N. Y. |
| "Barbco" | Ball & Roller Bearing Company, Danbury, Conn. |
| | Bantam Ball Bearing Company, Bantam, Conn. |
| | Bearings Company of America, Lancaster, Pa. |
| "B-N" | Burgess-Norton Mfg. Company, Geneva, Illinois. |
| | Fafner Bearing Company, New Britain, Conn. |
| | Federal Bearings Company, Poughkeepsie, N. Y. |
| | G-A Ball Bearing Company, Chicago, Ill. |
| | Graham Roller Bearing Corporation, Coudersport, Pa. |
| | Gurney Ball Bearing Company, Jamestown, N. Y. |
| | Imperial Bearing Company, Detroit, Mich. |
| | Joy Ball Bearing Company, Chicago, Ill. |
| "S. R. B." | Marlin-Rockwell Corporation, New York, N. Y. |
| | Matthews Manufacturing Company, Seymour, Conn. |
| | New Departure Manufacturing Company, Bristol, Conn. |
| | Nice Ball Bearing Company, Philadelphia, Pa. |

## BEARINGS (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Norma Company of America, Long Island City, N. Y. |
| | Pruyn Company, Philadelphia, Pa. |
| "Hess-Bright" | SKF Industries, Inc., New York, N. Y. |
| | S-W-S Company, Minneapolis, Minn. |
| | Schatz Manufacturing Company, Poughkeepsie, N. Y. |
| | Standard Machinery Company, Auburn, R. I. |
| | Teetsow Bearings Company, New York, N. Y. |
| "Strom" | U. S. Ball Bearing Mfg. Co., Chicago, Ill. |

### Roller Bearings

| | |
|---|---|
| "Trojan" | Ahlberg Bearing Company, Chicago, Ill. |
| | American Roller Bearing Co., Pittsburgh, Pa. |
| "Barbco" | Ball & Roller Bearing Company, Danbury, Conn. |
| | Bower Roller Bearing Company, Detroit, Mich. |
| | Gilliam Manufacturing Co., Canton, Ohio. |
| | Graham Roller Bearing Corp., Coudersport, Pa. |
| | Hart Roller Bearing Company, Orange, N. J. |
| | Hyatt Roller Bearing Company, Detroit, Mich. |
| "Twinro" | Makutchan Roller Bearing Co., Joliet, Ill. |
| "S. R. B." | Marlin-Rockwell Corporation, New York, N. Y. |
| | Norma Company of America, Long Island City, N. Y. |
| "Dohner" | Ohio Metal Products Co., Detroit, Mich. |
| | Shafer Bearing Corporation, Chicago, Ill. |
| "Gilliam" | Spencer Metal Products Co., Spencer, Ohio. |
| | Standard Machinery Company, Auburn, R. I. |
| "Bock" | Standard Parts Company, Cleveland, Ohio. |
| "F. W. S." | Stewart Manufacturing Corp., Chicago, Ill. |
| | Timken Roller Bearing Company, Canton, Ohio. |
| | Whitney Bearing Corporation, Chicago, Ill. |
| | Wright Roller Bearing Company, Philadelphia, Pa. |

### Die Cast Bearings

| | |
|---|---|
| | Acme Die-Casting Corporation, Brooklyn, N. Y. |
| | Alemite Die Casting & Mfg. Co., Chicago, Ill. |
| | American Bearing & Die Casting Corp., Indianapolis, Ind. |
| "Tenso" | Barnhart Brothers & Spindler, Chicago, Ill. |
| | Bridgeport Silverware Mfg., Corp., Bridgeport, Conn. |
| | Bronze Die Casting Company, Pittsburgh, Pa. |
| | Buffalo Bronze Die Casting Corp., Buffalo, N. Y. |
| | Burns-Croft Company, Chicago, Ill. |
| | Die Casting Company of New Jersey, Irvington, N. J. |
| "Do-Di" | Doehler Die Casting Company, Brooklyn, N. Y. |
| "Do-Lite" | Doehler Die Casting Company, Brooklyn, N. Y. |
| | Erie Bronze Company, Erie, Pa. |
| | Franklin Die Casting Corp., Syracuse, N. Y. |
| | Perry E. Fritz, Los Angeles, Calif. |
| "Ring-True" | General Aluminum & Brass Mfg. Co., Detroit, Mich. |
| | Grey Manufacturing Company, East Orange, N. J. |
| | Harley Company, Springfield, Mass. |
| | Hoyt Metal Company, St. Louis, Mo. |
| | Keystone Die Casting Co., Norristown, Pa. |
| | Kidder-Oswald Company, Dayton, Ohio. |
| | Kinite Company, Milwaukee, Wis. |
| | Legler-Eilerman Company, Dayton, Ohio. |
| | Levering Brothers, Baltimore, Md. |
| | Light Manufacturing & Foundry Co., Pottstown, Pa. |
| | Marf Machine Company, New York, N. Y. |
| | Mead and Cross, New York, N. Y. |
| | Metalware Corporation, Chicago, Ill. |
| | Michigan Smelting & Refining Co., Detroit, Mich. |
| | Milwaukee Die Casting Co., Milwaukee, Wis. |
| "Victor" | Modern Die & Tool Co., Indianapolis, Ind. |
| | Mogul Metal Company, Detroit, Mich. |
| | Mount Vernon Metal Products Co., Mount Vernon, N. Y. |
| | Mueller Metals Company, Port Huron, Mich. |
| | Muzzy-Lyon Company, Detroit, Mich. |
| | National Lead Company, New York, N. Y. |

## BEARINGS (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Parker White Metal & Machine Co., Erie, Pa. |
| | Phoenix Die Casting Company, Buffalo, N. Y. |
| | Precision Castings Company, Syracuse, N. Y. |
| | Recording Devices Company, Dayton, Ohio. |
| | Sall Company, Chicago, Ill. |
| | Sanford Company, Bridgeport, Conn. |
| | Sargent & Company, New Haven, Conn. |
| | Soss Manufacturing Company, Brooklyn, N. Y. |
| | Standard Die Casting Company, Milwaukee, Wis. |
| | Stewart Manufacturing Corp., Chicago, Ill. |
| | Stroh Die Moulded Casting Co., Milwaukee, Wis. |
| | United Bronze Co. of Pittsburgh, Pittsburgh, Pa. |
| | Universal Bearings Company, Loraine, Ohio. |
| | Veeder Manufacturing Company, Hartford, Conn. |
| | Victor Die Casting Machine Co., Ypsilanti, Mich. |
| | Victoria Metal Company, Erie, Pa. |
| | Vulcan Die Casting Corp., Syracuse, N. Y. |
| | White Brass Casting Company, Chicago, Ill. |
| | Wing & Company, Detroit, Mich. |

## BELLS AND BUZZERS, ELECTRIC

| | |
|---|---|
| "Acme" | Ansonia Electrical Company, Ansonia, Conn. |
| "Nutmeg" | Ansonia Electrical Company, Ansonia, Conn. |
| "Eureka" | Ansonia Electrical Company, Ansonia, Conn. |
| "Wizard" | Ansonia Electrical Company, Ansonia, Conn. |
| "3 in 1" | Buhl, C. H., Cleveland, Ohio. |
| "Reeko" | Bunnell & Company, J. H., New York, N. Y. |
| "J. C." | Clemens Electrical Corp., Buffalo, N. Y. |
| | Connecticut Telephone & Electric Company, Meriden, Conn. |
| "Auto-Recti" | Edwards & Company, New York, N. Y. |
| "Cadet" | Edwards & Company, New York, N. Y. |
| "Eco" | Edwards & Company, New York, N. Y. |
| "Economy" | Edwards & Company, New York, N. Y. |
| "Lungen" | Edwards & Company, New York, N. Y. |
| "R. E. A. L." | Edwards & Company, New York, N. Y. |
| "Recti" | Edwards & Company, New York, N. Y. |
| "Riot" | Edwards & Company, New York, N. Y. |
| "Vigilant" | Edwards & Company, New York, N. Y. |
| "Cyclone" | Electrical Sales Company, Boston, Mass. |
| "M. C. R. R." | Electrical Sales Company, Boston, Mass. |
| "Missouri Pacific" | Electrical Sales Company, Boston, Mass. |
| "Schwarze" | Electrical Sales Company, Boston, Mass. |
| "Turtle Back" | Electrical Sales Company, Boston, Mass. |
| "Eureka" | Electric Signal Mfg. Company, Orange, N. Y. |
| "Ideal" | Haas Electric & Mfg. Company, Springfield, Ill. |
| "Duplex" | Hersh Electric Specialty Company, Milwaukee, Wis. |
| "A-D" | Holtzer-Cabot Electric Company, Boston, Mass. |
| "Hub-drome" | Holtzer-Cabot Electric Company, Boston, Mass. |
| | Keil & Son, Francis, New York, N. Y. |
| | Klaxon Company, Newark, N. J. |
| "Duplex" | Klein Electric & Mfg. Company, Buffalo, N. Y. |
| "Crescendo" | Manhattan Electrical Supply Co., New York, N. Y. |
| "Crescent" | Manhattan Electrical Supply Co., New York, N. Y. |
| "Imperial" | Manhattan Electrical Supply Co., New York, N. Y. |
| "Monitor" | Manhattan Electrical Supply Co., New York, N. Y. |
| "Nonpareil" | Manhattan Electrical Supply Co., New York, N. Y. |
| "Peerless" | Manhattan Electrical Supply Co., New York, N. Y. |
| "Premier" | Manhattan Electrical Supply Co., New York, N. Y. |
| "Utility" | Manhattan Electrical Supply Co., New York, N. Y. |
| | Ostrander & Company, W. R., New York, N. Y. |
| | Partrick & Wilkins Company, Philadelphia, Pa. |
| "Mono-Seal" | Russell Electric Company, Danbury, Conn |
| "Star" | Samson Electric Company, Canton, Mass. |
| | Signal Electric Mfg. Company, Menominee, Mich. |
| "Selco" | Spies Electric Company, Chicago, Ill. |
| "Eclipse" | Stanley & Patterson, New York, N. Y. |
| "Ekla" | Stanley & Patterson, New York, N. Y. |

## BEARINGS (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| "Composition" | Stanley & Patterson, New York, N. Y. |
| "Columbia" | Stanley & Patterson, New York, N. Y. |
| "Globe" | Stanley & Patterson, New York, N. Y. |
| "Monitor" | Stanley & Patterson, New York, N. Y. |
| "Marie" | Stanley & Patterson, New York, N. Y. |
| "Rex" | Stanley & Patterson, New York, N. Y. |
| "Faraday" | Stanley & Patterson, New York, N. Y. |
| "PR" | Stanley & Patterson, New York, N. Y. |
| "Straight Line" | Stanley & Patterson, New York, N. Y. |

## BENCHES, VISE, PORTABLE

- Henderson Electric Company, Ampere, N. J.
- Martin & Sons, H. P., Owensboro, Ky.
- Standard Iron Works, New York, N. Y.

## BLOWERS (Air Driers)

| | |
|---|---|
| "Cyclone" | American Blower Company, Detroit, Mich. |
| "Sirocco" | American Blower Company, Detroit, Mich. |
| "Keith" | American Keith Company, New York, N. Y. |
| "Autovent" | Autovent Fan & Blower Co., Chicago, Ill. |
| "Bicalky" | Autovent Fan & Blower Co., Chicago, Ill. |
| | Barney Ventilating Fan Works, Boston, Mass. |
| | Bayley Manufacturing Company, Milwaukee, Wis. |
| "Bresco" | Buffalo Forge Company, Buffalo, N. Y. |
| "Four Leaf Clover" | Centrifugal Fan Company, Newark, N. J. |
| | Dayton Fan & Motor Company, Dayton, Ohio. |
| | Eck Dynamo & Motor Company, Belleville, N. J. |
| "Marvel" | Electric Blower Company, Boston, Mass. |
| | Emerson Electric Manufacturing Company, St. Louis, Mo. |
| | Fidelity Electric Company, Lancaster, Pa. |
| "Whirlwind" | Fuchs, Otto, A., New York, N. Y. |
| | Garden City Fan Company, Chicago, Ill. |
| "Davidson" | General Electric Company, Schenectady, N. Y. |
| "Ventura" | General Electric Company, Schenectady, N. Y. |
| | Green Fuel Economizer Company, New York, N. Y. |
| | Hatch & Sullivan, Exeter, N. H. |
| "Blackman" | Howard & Morse, New York, N. Y. |
| "National" | Howard & Morse, New York, N. Y. |
| "Ilgair" | Ilg Electric Ventilating Company, Chicago, Ill. |
| | Improved Appliance Co., Brooklyn, N. Y. |
| | Indiana Fan Company, Indianapolis, Ind. |
| | Kimble Electric Company, Chicago, Ill. |
| | Marathon Electric Manufacturing Co., Warsaw, Wis. |
| | Massachusetts Blower Company, Watertown, Mass. |
| "Watson" | Mechanical Appliance Company, Milwaukee, Wis. |
| "Univent" | Moline Heat Company, Moline, Ill. |
| | New York Blower Company, Chicago, Ill. |
| | Peerless Electric Company, Warren, Ohio. |
| | Perkins & Sons, Holyoke, Mass. |
| | Protective Ventilator & Screen Corp., New York, N. Y. |
| | Robbins & Myers Company, Springfield, Ohio. |
| | Rochester Electric Products Corp., Rochester, N. Y. |
| "Roto" | Rosewater Electric Company, Cleveland, Ohio. |
| | Seymour, Jr., J. M., Newark, N. J. |
| | Sturtevant Company, B. F., Hyde Park, Mass. |
| "Scruplex" | Wing Mfg. Company, L. J., New York, N. Y. |
| "Typhoon" | Wing Mfg. Company, L. J., New York, N. Y. |

## BOXES (Floor, Junction and Outlet)

| | |
|---|---|
| "Adapti" | Adapti Company, Cleveland, Ohio |
| "Allsteel" | All-Steel Equipment Company, Aurora, Ill. |
| "Unilets" | Appleton Electric Company, Chicago, Ill. |
| | Aurora Steel Products Company, Aurora, Ill. |
| | Austin Company, M. B., Chicago, Ill. |

## BOXES (Floor, Junction and Outlet) (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Barber Electric Mfg. Company, Chicago, Ill. |
| "Youmans" | Barlow Electric Specialties Company, Yonkers, N. Y. |
| | Berry-Glosser Company, Marion, Ohio. |
| | Bonnell Electric Mfg. Company, New York, N. Y. |
| | Burns, J. F., Philadelphia, Pa. |
| | Canton Specialty Company, Canton, Ill. |
| | Chelten Electric Company, Philadelphia, Pa. |
| "Gem" | Chicago Fuse Mfg. Company, Chicago, Ill. |
| "Union" | Chicago Fuse Mfg. Company, Chicago, Ill. |
| "Sterling" | Clemence Brothers, Irvington, N. J. |
| "Meleady" | Clemence Brothers, Irvington, N. J. |
| | Cole Metal Products Company, New York, N. Y. |
| "Rex" | Colgan Company, W. H., West Newton, Mass. |
| | Columbia Metal Box Company, New York, N. Y. |
| | Columbian Steel Tank Company, Kansas City, Mo. |
| | Connecticut Electric Mfg. Co., Bridgeport, Conn. |
| "Diamond C" | Consolidated Electric Mfg. Co., Philadelphia, Pa. |
| "Condulets" | Crouse-Hinds Company, Syracuse, N. Y. |
| "Snap" | E. & B. Manufacturing Company, Detroit, Mich. |
| | Electric Box & Cover Company, Newark, N. J. |
| | Fancleve Specialty Company, Boston, Mass. |
| | Federal Electric Company, Chicago, Ill. |
| | Federal Electric & Mfg. Company, Pittsburgh, Pa. |
| "Kwikon" | Fralick & Company, S. R., Chicago, Ill. |
| | General Electric Company, Schenectady, N. Y. |
| | General Machine & Mfg. Company, Bridgeport, Conn. |
| | Gould, Harry, V., Bridgeport, Conn. |
| | Greater New York Metal Box Co., Inc., New York, N. Y. |
| "S. & H." | G. & W. Electric Specialty Company, Chicago, Ill. |
| "All-In-O" | Habermaas & Delporte, Inc., St. Louis, Mo. |
| | Haris, John, R., Pittsburgh, Pa. |
| "Fountain's" | Hart, Raymond, S., New York, N. Y. |
| | Hart & Hegeman Manufacturing Company, Hartford, Conn. |
| | Ideal Electric Manufacturing Co., Philadelphia, Pa. |
| | Johns-Manville, Inc., New York, N. Y. |
| | Kam-Lok Switch Box Company, New York, N. Y. |
| | Knight Company, J. G., Brooklyn, N. Y. |
| "Dandy" | Kusel Telephone & Electric Supply Co., St. Louis, Mo. |
| | Laganke Electric Company, Cleveland, Ohio. |
| "Mesco" | Manhattan Electrical Supply Co., New York, N. Y. |
| | Mansfield Electrical Hardware Mfg. Co., Mansfield, Ohio. |
| | Michigan Stamping Company, Detroit, Mich. |
| | Motor City Stamping Company, Detroit, Mich. |
| "Atlas" | Multiple Electrical Products Co., New York, N. Y. |
| "4 in 1" | Multiple Electrical Products Co., New York, N. Y. |
| | National Metal Molding Company, Pittsburgh, Pa. |
| | Oliver Electric & Mfg. Company, St. Louis, Mo. |
| | Ostrander & Company, W. R., New York, N. Y. |
| | Overbagh Company, Chicago, Ill. |
| "Bau" | Pratt Chuck Company, Frankfort, N. Y. |
| | Renim Specialty Company, Boston, Mass. |
| | Rice Company, G. H., Brooklyn, N. Y. |
| | Royal Metal Box Company, Brooklyn, N. Y. |
| | Russell & Stoll Company, New York, N. Y. |
| | Safety Electric Products Company, Los Angeles, Calif. |
| | Seidler-Miner Company, Detroit, Mich. |
| | Service Electric Company, New York, N. Y. |
| "Seco" | Sieffert Electric Company, Evansville, Ind. |
| "Multilet" | Sprague Electric Works of General Electric Co., New York, N. Y. |
| | Standard Electrical Mfg. Company, Cleveland, Ohio. |
| "Patterson" | Stanley & Patterson, New York, N. Y. |
| "Fullman" | Steel City Electric Company, Pittsburgh, Pa. |
| | Superior Metal Products Company, Kansas City, Mo. |
| "Columbus" | Thomas & Betts Company, New York, N. Y. |
| "Stahley" | Thomas & Betts Company, New York, N. Y. |
| | United Metal Box Company, New York, N. Y. |
| | **Westinghouse Electric & Mfg. Company, Brooklyn, N. Y.** |
| | Wurdack Electric Mfg. Company, St. Louis, Mo. |

## CARBURETORS

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Air-Friction Carburator Company, Dayton, Ohio. |
| | Ames Carburator Company, Racine, Wisconsin. |
| | Atkins Company, E. G., Mansfield, Ohio. |
| "Tolmie" | Beacon Bronze Company, Beacon, N. Y. |
| "Rayfield" | Beneke & Kropf Manufacturing Co., Chicago, Ill. |
| | Booty Carburator Manufacturing Co., Chicago, Ill. |
| "Gilles" | Brandenburg Bros. & Eccleston, Chicago, Ill. |
| "Scoe" | Briescoe Devices Company, Pontiac, Mich. |
| | Brown Carburetor Company, New York, N. Y. |
| "Kingston" | Byrne, Kingston & Company, Kokomo, Ind. |
| "Knox" | Camden Anchor-Rockland Machine Co., Camden, Me. |
| | Carter Carburetor Company, St. Louis, Mo. |
| | Claudel Carburetor Co., Long Island City, N. Y. |
| "Stewart" | Detroit Lubricator Company, Detroit, Mich. |
| "D. K. W." | Duquesne Auto Accessory Company, New Kensington, Pa. |
| | Eagle Carburetor Company, Cleveland, Ohio. |
| | Fulton-Greuter Engineering Co., Cincinnati, Ohio. |
| | G. & A. Carburetor Company, New York, N. Y. |
| | Gardner Auto Products Company, Detroit, Mich. |
| | Gill Manufacturing Company, Cleveland, Ohio. |
| | H. & N. Carburetor Company, Long Island City, N. Y. |
| | Heath Products Corporation, Detroit, Mich. |
| "Heco" | Heinze Electric Company, Lowell, Mass. |
| | Hess Mercury Carburetor Company, Valparaiso, Ind. |
| "Newcomb" | Holtzer-Cabot Electric Company, Boston, Mass. |
| | Johnson Company, Detroit, Mich. |
| | Juhasz Carburetor Company, New York, N. Y. |
| "Parkin" | Light Manufacturing & Fdry. Co., Pottstown, Pa. |
| | Marvel Carburetor Company, Flint, Mich. |
| | Master Carburetor Company, Los Angeles, Calif. |
| | Miller Manufacturing Co., Los Angeles, Calif. |
| "Ball & Ball" | Penberthy Injector Company, Detroit, Mich. |
| "Ess-Ess" | Scott & Sons Company, Medford, Mass. |
| "Ball Spray" | Shain, Charles, D., Brooklyn, N. Y. |
| | Simplex No-Flote Carburetor Co., Detroit, Mich. |
| | Stokes Carburetor Company, New York, N. Y. |
| | Stromberg Motor Devices Co., Chicago, Ill. |
| "M. T.," "Nitro" | Sunderman Corporation, Newburgh, N. Y. |
| | Tillotson Manufacturing Co., Toledo, Ohio. |
| | Toquet Carburetor Corporation, New York, N. Y. |
| | Trader & Company, R. V., McKeesport, Pa. |
| | U. & J. Carburetor Company, Chicago, Ill. |
| "Caloretor" | Vaporator Corporation, Milwaukee, Wis. |
| | Webber Manufacturing Company, Boston, Mass. |
| "Schebler" | Wheeler-Schebler Carburetor Co., Indianapolis, Ind. |
| "Bennett" | Wilcox-Bennett Carburetor Co., Minneapolis, Minn. |
| "Justrite" | Wilcke-Armstrong Company, Detroit, Mich. |
| "Swan" | Yale & Towne Manufacturing Co., Stamford, Conn. |
| | Zenith Carburetor Company, Detroit, Mich. |

## CHEMICALS FOR BATTERIES

| | |
|---|---|
| | Contact Process Company, Buffalo, N. Y. |
| | Cooper & Company, C., New York, N. Y. |
| | Du Pont de Nemours & Co., New York, N. Y. |
| | Eagle-Pitcher-Lead Co., Chicago, Ill. |
| | Elmer & Amend, New York, N. Y. |
| | Globe Chemical Company, Cincinnati, Ohio. |
| | Grasselli Chemical Company, Cleveland, Ohio. |
| | Kalbfleisch Corporation, New York, N. Y. |
| | Klipstein Company, New York, N. Y. |
| | Merimac Chemical Company, Boston, Mass. |
| | New Jersey Zinc Company, New York, N. Y. |
| "Voltak" | Powers-Weightman-Rosengarten Co., Philadelphia, Pa |

## CHURNS

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | American Stamping & Enameling Co., Bellaire, O. |
| "Eureka" | Aquatic Cream Separator Co., Rochester, N. Y. |
| "Jackson" | Babcock Co., W. W., Bath, N. Y. |
| "Ash Dash," "Bent Wood," "Brown" | Brown Co., M., Wapakoneta, O. |
| "Ash Dasher," "Buckeye," "Climax," "Eureka" | Buckeye Church Co., Sidney, O. |
| "Simplex" | Burrell & Co., D. H., Little Falls, N. Y. |
| | Constance Lumber Co., Mansfield, O. |
| "C. P." | Creamery Package Mfg. Co., Chicago, Ill |
| | Davis-Watkins Dairymen's Mfg. Co., N. Chicago, Ill |
| "Dazey" | Dazey Churn & Mfg. Co., St. Louis, Mo |
| "Favorite" | Dobson Mfg. Co., Rockford, Ill. |
| "Blanchard," "Cylinder," "Lightning" | Hall Brothers Co., West Acton, Mass. |
| | Hill, W. C., Brasher Falls, N. Y. |
| | Hodges & Co., W., Philadelphia, Pa. |
| | Kohler Die & Specialty Co., De Kalb, Ill. |
| "Universal" | Landers, Frary & Clark, New Britain, Conn. |
| "Lisk" | Lisk Mfg. Co., Canandaigua, N. Y. |
| | Lown & Son, Poughkeepsie, N. Y. |
| "Belle," "Star" | McDermaid, J., Rockford, Ill. |
| "Challenge" | Mason Mfg. Co., Canton, O. |
| | Minnetonna Co., Owatonna, Minn. |
| "Bell," "Cattaraugus," "Disbrow," "Victor," | Oakes & Burger Co., Cattaraugus, N. Y. |
| "New Owatonna" | Owatonna Fanning Mill Co., Owatonna, Minn. |
| "Dual" | Owatonna Mfg. Co., Owatonna, Minn. |
| "Rectangular," "Reid" | Reid Creamery & Dairy Supply Co., Philadelphia, Pa. |
| "White Cedar" | Richmond Cedar Wks., Richmond, Va. |
| "Roberts" | Roberts Lightning Mixer Co., Boston, Mass. |
| "Owatonna" | Rumley Leo Tractor Co., La Porte, Ind. |
| | Schroeder Mfg. Co., Minier, Ill. |
| "O. K.," "Standard" | Standard Churn Co., Wapakoneta, O. |
| | Sturges & Burn Mfg. Co., Chicago, Ill. |
| "Superior" | Superior Churn & Mfg. Co., Northville, Mich. |
| "Reliable" | Taylor Bros. Churn & Mfg. Co., St. Louis, Mo. |
| | Thomas Mfg. Co., Dayton, O. |
| | Uhl Pottery Co., Evansville, Ind. |
| "V. F. M.," "Vermont," "Davis" | Vermont Farm Machine Co., Bellows Falls, Vt. |

## CIRCUIT BREAKERS

| | |
|---|---|
| | Allen-Bradley Co., Milwaukee, Wis. |
| | Anderson Mfg. Co., Boston, Mass. |
| "Basco" | Briggs & Stratton Co., Milwaukee, Wis. |
| | Conduit Electrical Mfg. Co., S. Boston, Mass. |
| "I-T-E" | Cutter Electrical & Mfg. Co., Philadelphia, Pa. |
| | General Electric Co., Schenectady, N. Y. |
| | Kelman Electric & Mfg. Co., Los Angeles, Cal. |
| | Line Material Co., S. Milwaukee, Wis. |
| "Rolkinson" | Mohawk Electric Mfg. Co., Newark, N. J. |
| | Monarch Electric Co., Ltd., St. Lambert, Can. |
| | Pacific Electric Mfg. Co., San Francisco, Cal. |
| | Roller-Smith Co., 233 Bway., New York. |
| "S. & C." | Schweitzer & Conrad, Inc., Chicago, Ill. |
| | Sundh Electric Co., Newark, N. J. |
| | Takamine Commercial Corp., 120 Bway., New York. |
| | Ward Leonard Electric Co., Mt. Vernon, N. Y. |
| | **Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.** |

## CLIPPING MACHINES

| | |
|---|---|
| "Priest's" | American Shearer Mfg. Company, Nashua, N. H. |
| | Andis Manufacturing Company, Racine, Wis. |
| "Clarks" | Bartley Brothers & Hall, New York, N. Y. |
| "Stewart" | Chicago Flexible Shaft Company, Chicago, Ill. |
| | Coates Clipper Manufacturing Company, Worcester, Mass. |
| | **Gillette Clipping Machine Company, New York, N. Y.** |
| | Packer & Sons, La Grange, Ill. |
| "Reliable" | Reliable Electric Company, Chicago, Ill. |

## CONNECTORS

### Battery Connectors

| Trade Name | Name and Address of Manufacturer |
|---|---|
| "Bull Dog" | American Ever Ready Works of Nat'l Carbon Co., Long Island City, N. Y. |
| | Barcy & Nicholson, Detroit, Mich. |
| | Belden Manufacturing Company, Chicago, Ill. |
| | Breaznell, J. H., Brooklyn, N. Y. |
| | Fahnestock Electric Company, Long Island City, N. Y. |
| "Perfection" | Fitzgerald Manufacturing Co., Torrington, Conn. |
| | Ideal Clamp Manufacturing Co., Brooklyn, N. Y. |
| "All-Redi," "Sta-There" | Manhattan Electrical Supply Co., New York, N. Y. |
| | Morse, F. W., Boston, Mass. |
| | Salem Electrical Supply Company, Salem, Mass. |
| | Chain, C. D., Brooklyn, N. Y. |
| | Sherman Manufacturing Co., Battle Creek, Mich. |
| "Securo" | Stevens & Company, New York, N. Y. |
| | Van Woert, L. R., Rutherford, N. J. |

### Fixture Connectors

| | |
|---|---|
| | Cruban Machine & Steel Corp., New York, N. Y. |
| "Notorch" | Columbia Metal Box Company, New York, N. Y. |
| | Dossert & Company, New York, N. Y. |
| | Sherman Mfg. Company, H. B., Battle Creek, Mich. |
| | Simpson, A. B., New York, N. Y. |
| "Mellorate" | Standard Scientific Co., New York, N. Y. |
| "Walger" | Stover & Company, S. H., Pittsburgh, Pa. |
| | Usem Company, New York, N. Y. |

## CREAM SEPARATORS

| | |
|---|---|
| | American Separator Co., Bainbridge, N. Y. |
| | Anker-Holth Mfg. Co., Port Huron, Mich |
| | Associated Mfrs. Co., Waterloo, Ia. |
| "Champion," "Standard" | Blanke Mfg. & Supply Co., St. Louis, Mo. |
| "Primes" | Buckeye Churn Co., Sidney, O. |
| | Buckeye Cream Separator Co., Oberlin, O. |
| "Simplex" | Burrell Co., D. H., Little Falls, N. Y. |
| "Champion" | Champion Blower & Forge Co., Lancaster, Pa. |
| | Chapman Cream Separator Wks., Erie, Pa. |
| | Cleveland Cream Separator Co., Cleveland, O. |
| | Creamery Package Mfg. Co., Chicago, Ill. |
| "Dairy Queen" | Dairy Cream Separator Co., Lebanon, Ind. |
| | Davis, J. H., Sparte, Wis. |
| "Davis" | Davis-Watkins Dairymen's Mfg. Co., N. Chicago, Ill. |
| "De Laval" | De Laval Separator Co., 165 Bway., New York. |
| "Success" | Deschler Mail Box Co., Deschler, O. |
| | Diller Mfg. Co., Bluffton, O. |
| "Empire-Baltic" | Empire Cream Separator Co., Bloomfield, N. J. |
| | Fisk, E. W., Newark, N. Y. |
| | Galloway Co., W., Waterloo, Ia. |
| "Primrose-Lily" | International Harvester Co., Chicago, Ill. |
| | King Drill Mfg. Co., Nebraska City, Neb. |
| | Lawrence-Bostwick Mfg. Co., Phelps, N. Y. |
| "Lisk" | Lisk Mfg. Co., Canandaigua, N. Y. |
| "Monarch" | Lisle Mfg. Co., Clarinda, Ia. |
| "Milwaukee" | Milwaukee Separator Mfg. Co., Milwaukee, Wis. |
| | Murphy Die & Machine Co., Boston, Mass. |
| "National" | National Dairy Machine Co., Goshen, Ind. |
| "National" | National Enameling & Stamping Co., New York. |
| | Papec Machine Co., Shortsville, N. Y. |
| "Reid" | Reid Creamery & Dairy Supply Co., Philadelphia, Pa. |
| "Omega" | Reliance Engineering Co., Lansing, Mich. |
| | Renfrew Machinery Co., Milwaukee, Wis. |
| "Great Western" | Rock Island Farm Equipment Co., Rock Island, Ill. |
| "Banner" | Seither & Cherry Co., Keokuk, Ia. |
| "Sharples" | Sharples Separator Co., West Chester, Pa. |
| "Automatic" | Standard Separator Co., Milwaukee, Wis. |
| | Starch Brothers, La Crosse, Wis. |
| "Superior" | Superior Sheet Metal Wks. Co., Indianapolis, Ind. |

## CREAM SEPARATORS (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Swedish Separator Co., Chicago, Ill. |
| "Diabolo" | United Engine Co., Lansing, Mich. |
| | Vega Separator Co., Fostoria, O. |
| "United States" | Vermont Farm Machine Co., Bellows Falls, Vt. |
| "Waterloo Boy" | Waterloo Gasoline Engine Co., Waterloo, Ia. |
| | Wayte, W. J., New York, N. Y. |
| | Weber Kirch Mfg. Co., Keokuk, Ia. |
| | Worthington Pump & Mchry. Corp., 115 Bway., New York. |

## CURRENT INDICATORS

| | |
|---|---|
| | American Radio & Research Corp., 21 Park Row, New York. |
| "Berghman" | Berghman Co., Chicago, Ill. |
| "Majestic Determinator" | Majestic Electric Development Co., San Francisco, Cal. |
| "S & C" | Schweitzer & Conrad, Inc., Chicago, Ill. |
| | **Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.** |
| | Weston Electrical Instrument Co., Newark, N. J. |

## ELECTRIC FANS

| | |
|---|---|
| | Bodine Electric Company, Chicago, Ill. |
| | Century Electric Company, St. Louis, Mo. |
| | Dayton Fan & Motor Company, Dayton, Ohio. |
| "Diehl" | Diehl Manufacturing Company, Elizabeth, N. J. |
| "Acme" | Dilg Manufacturing & Trading Company, New York, N. Y. |
| "Hurricane" | Eck Dynamo & Motor Company, Belleville, N. J. |
| "Northwind" | Emerson Electric Manufacturing Co., St. Louis, Mo. |
| | Fidelity Electric Company, Lancaster, Pa. |
| "Star" | Fitzgerald Manufacturing Co., Torrington, Conn. |
| "GE" | General Electric Company, Schenectady, N. Y. |
| "Polar Cub" | Gilbert Company, A. C., New Haven, Conn. |
| "Cyclone" | Hamilton-Beach Manufacturing Co., Racine, Wis. |
| "H. E.," "Tuerk" | Hunter Fan & Motor Co., New York, N. Y. |
| | Kendrick & Davis Company, Lebanon, N. H. |
| "Handy," Limo-Sedan" | Knapp Electric & Novelty Co., New York, N. Y. |
| "Storm Wave" | Logansport Machine Co., Logansport, Ind. |
| "Gyrofan" | National Screw & Tack Co., Cleveland, Ohio. |
| "White Cross" | National Stamping & Electric Works, Chicago, Ill. |
| "Peerless" | Peerless Electric Company, Warren, Ohio. |
| | Pittsburgh Electric Specialties Co., New York, N. Y. |
| "Standard" | Robbins & Myers Company, Springfield, Ohio. |
| | Star Electric Motor Co., Newark, N. J. |
| "Menominee" | Tideman Electric Manufacturing Co., Cairo, Ill. |
| **Western Electric** | **Western Electric Company, New York, N. Y.** |
| **"Westinghouse"** | **Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.** |

## ELECTRIC FLASHLIGHTS

| | |
|---|---|
| | American Carbon & Battery Co., East St. Louis, Ill. |
| "Eveready" | American Ever Ready Works of National Carbon Co., L. I. City, N. Y. |
| "Midget" | Bailey Company, W. J., Newark, N. J. |
| "Fire Fly" | Burleigh, George K., Penacook, N. H. |
| | Delta Electric Company, Marion, Ind. |
| | Diamond Electric Specialties Corp., Newark, N. J. |
| | Dressel Manufacturing Corp., New York, N. Y. |
| | Federal Sign System, Chicago, Ill. |
| | Franco Electric Corp., Brooklyn, N. Y. |
| | Grether Fire Equipment Co., Dayton, Ohio |
| "Hipco" | Hipwell Manufacturing Co., Pittsburgh, Pa. |
| "Presto" | Metal Specialties Mfg. Co., Chicago, Ill. |
| | Novo Manufacturing Co., New York, N. Y. |
| "Rosco" | Rosen & Company, New York, N. Y. |
| | Smith Manufacturing Co., F. A., Rochester, N. Y. |
| | Universal Carbon Company, Dundee, Ill. |
| "Kwik Lite" | Usona Manufacturing Company, New York, N. Y. |
| "O-U-Lyte" | Weder Company, Philadelphia, Pa. |

## ENGINES, GASOLINE, KEROSENE

| Trade Name | Name and Address of Manufacturer |
|---|---|
| "Oilturn" | Advance Rumely Co., La Porte, Ind. |
| "Alamo" | Alamo Engine Co., Hillsdale, Mich. |
| "Armstrong" | American Engine & Foundry Co., Charles City, Ia. |
| | Anderson Foundry & Machine Works, Anderson, Ind. |
| | Appletown Mfg. Co., Batavia, Ill. |
| "Big Ben" | Benninghofen & Sons, C., Hamilton, O. |
| "Bessemer" | Bessemer Gas Engine Co., Grove City, Pa. |
| | Buda Co., Harvey, Ill. |
| | Buffalo Foundry & Machine Co., Buffalo, N. Y. |
| | Challenge Co., Batavia, Ill. |
| | Christensen Engineering Co., Milwaukee, Wis. |
| "Giant" | Chicago Pneumatic Tool Co., New York, N. Y. |
| | Clark Engine & Boiler Co., Kalamazoo, Mich. |
| "Red Seal" | Continental Motors Corp., Detroit, Mich. |
| | Cooper Co., C. & G., Mt. Vernon, O. |
| | Cushman Motor Works, Lincoln, Neb. |
| | Davenport Mfg. Co., Davenport, Ia. |
| | De La Vergne Machine Co., New York, N. Y. |
| "Dunn' | Dunn Mfg. Co., Holland, Mich. |
| "Eagle" | Eagle Mfg. Co., Appleton, Wis. |
| | Ellis Engine Co., Detroit, Mich. |
| "E-B" | Emerson-Brantingham Co., Rockford, Ill. |
| | Evinrude Motor Co., Milwaukee, Wis. |
| "Y," "Z" | **Fairbanks, Morse & Co., Chicago, Ill.** |
| | Fairmont Gas Engine & Railway Motor Car Co., Fairmont, Minn. |
| | Fay & Bowen Engine Co., Geneva, N. Y. |
| | Foos Gas Engine Co., Springfield, O. |
| | Frisbie Motor Co., Middletown, Conn. |
| | Fuller & Johnson Mfg. Co., Madison, Wis. |
| "Monarch" | Grand Rapids Gas Engine Co., Grand Rapids, Mich. |
| | Gray Motor Co., Detroit, Mich. |
| "Hercules" | Hercules Corp., Evansville, Ind. |
| | Hoyer Engineering Co., Milwaukee, Wis. |
| | Ingersoll-Rand Co., New York, N. Y. |
| | International Harvester Co. of America, Inc., Chicago, Ill. |
| "Bud-E" | Johnson Machine Co., Manchester, Conn. |
| "Jones" | Jones Oil Engine Corp., Syracuse, N. Y. |
| "Barber" | King Brothers, Syracuse, N. Y. |
| "Wisconsin" | Lauson-Lawton Co., De Pere, Wis. |
| | LeRoi Co., Milwaukee, Wis. |
| | Maytag Co., Newton, Ia. |
| | Midwest Engine Co., Indianapolis, Ind. |
| | Missouri Engine Co., St. Louis, Mo. |
| | Muncie Oil Engine Co., Muncie, Ind. |
| "Transit" | National Transit Pump & Machine Co., Oil City, Pa. |
| | Novo Engine Co., Lansing, Mich. |
| | Nordberg Mfg. Co., Milwaukee, Wis. |
| "Otto" | Otto Engine Mfg. Co., Philadelphia, Pa. |
| "Penmac" | Engine & Mfg. Co., New York, N. Y. |
| "Superior Piersen" | Piersen Mfg. Co., Topeka, Kans. |
| "Radiant" | Radiant Mfg. Co., Sandusky, O. |
| | Rawleigh Co., W. T., Freeport, Ill. |
| | Regal Gasoline Engine Co., Coldwater, Mich. |
| | Reliable Engine Co., Portsmouth, O. |
| "Reeco" | Rider-Ericsson Engine Co., Walden, N. Y. |
| "Reeco" | Rural Electric Equipment Co., Canton, Pa. |
| | St. Marys Oil Engine Co., St. Charles, Mo. |
| | Sandwich Mfg. Co., Sandwich, Ill. |
| | Smalley-General Co., Bay City, Mich. |
| | Spang & Co., Butler, Pa. |
| | Standard Gas Engine Co., Oakland, Cal. |
| | Stearns Motor Mfg. Co., Ludington, Mich. |
| "Sterling" | Sterling Engine Co., Buffalo, N. Y. |
| "Stover" | Stover Mfg. & Engine Co., Freeport, Ill. |
| | Sturtevant Co., B. F., Boston, Mass. |
| "Wiscona" | Termaat-Monahan Mfg. Co., Oshkosh, Wis. |
| "Simplicity" | Turner Mfg. Co., Port Washington, Wis. |
| "Union" | Union Gas Engine Co., Oakland, Cal. |

## ENGINES, GASOLINE, KEROSENE (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Venn-Severin Machine Co., Chicago, Ill. |
| | Waterloo Gasoline Engine Co., Waterloo, Ia. |
| | West Chester Engine Co., West Chester, Pa. |
| | Western Machinery Co., Los Angeles, Cal. |
| "Wisconsin" | Wisconsin Motor Mfg. Co., Milwaukee, Wis. |
| "Hercules" | Woodin & Little, San Francisco, Cal. |
| | Wright Machine Co., Owensboro, Ky. |

## FEED CUTTERS

| | |
|---|---|
| | Albright & Sons, J. H., Mifflinburg, Pa. |
| | Ames Plow Company, Boston, Mass. |
| "Cummings" | Ann Arbor Machine Co., Ann Arbor, Mich. |
| | Appleton Manufacturing Company, Batavia, Ill. |
| "Ostego" | Babcock Manufacturing Co., Leonardsville, N. Y. |
| "Baldwin," "Chicken," "Hide Roll," "Lion," "Gale Jr.," "New York," "Nonesuch," "Self-Sharpening," "Union," "Victor," | Belcher & Taylor Agr. Tool Co., Chicopee Falls, Mass. |
| "Belle City" | Belle City Manufacturing Co., Racine, Wis. |
| "Combination" | Bowsher Company, N. P., South Bend, Ind. |
| "Buch," "Lighthouse," "Nobby," "Pennsylvania," | Buch's Sons Co., A., Elizabethtown, Pa. |
| "Smith" | Cardwell Machine Company, Richmond, Va. |
| | Challenge Company, Batavia, Ill. |
| "Daisy" | Conner & Son, J. W., Orangeville, Pa. |
| "Alpine," "Dick's," "Famous" | Dick Manufacturing Co., Jos., Canton, Ohio. |
| "King" | Donaldson Brothers, Mount Clemens, Mich. |
| | Eagle Machine Company, Lancaster, Ohio. |
| "Dandy," "Eddy," "Yankee" | Eddy Plow Co., W., Greenwich, N. Y. |
| "Keystone" | Ellis Keystone Agricultural Works, Pottstown, Pa. |
| | **Fairbanks, Morse & Co., Chicago, Ill.** |
| "Clipper" | Farquhar Company, Ltd., York, Pa. |
| | Foster & Williams Manufacturing Co., Racine, Wis. |
| | Freeman Manufacturing Co., Racine, Wis. |
| "Silverzahn" | Gehl Brothers Manufacturing Co., West Bend, Wis. |
| "Smith" | Glascock Stove & Manufacturing Co., Greensboro, N. C. |
| | Greenville Implement Co., Greenville, Mich. |
| "Giant," Ideal" | Hamachek, Frank, Kewaunee, Wis. |
| "Handy" | Hamburg Plow Works, Hamburg, Pa. |
| "Tornado" | Harrison & Company, W. R., Massillon, Ohio. |
| "Union" | Heebner & Sons, Lansdale, Pa. |
| "Heller" | Heller-Aller Company, Napoleon, Ohio. |
| "Superior" | Hench & Dromgold Company, York, Pa. |
| "Boss," "Kokosing," "Hocking Valley," "Geneva," | Hocking Valley Manufacturing Co., Lancaster, Ohio. |
| | Keystone Machine Company, York, Pa. |
| "Monarch" | Lehr Agricultural Company, Fremont, Ohio. |
| "Triumph" | Lyon Iron Works, Green, N. Y. |
| | Messinger Manufacturing Co., Tatamy, Pa. |
| | Moore Plow & Implement Co., Greenville, Mich. |
| "Triumph" | Mountville Manufacturing Co., Mountville, Pa. |
| | Papec Machine Company, Shortsville, N. Y. |
| | Parlin & Orendorff Company, Canton, Ill. |
| "Little Giant," Ross" | Ross Company, E. W., Springfield, Ohio. |
| "Rowell" | Rowell Company, I. B., Waukesha, Wis. |
| "Ohio," "Plantation," "Pony" | Silver Manufacturing Co., Salem, Ohio. |
| | Smalley Manufacturing Company, Manitowoc, Wis. |
| | Star Manufacturing Company, Carpentersville, Ill. |
| "New No. 8," "Peerless" | Thornburgh Manufacturing Co., Bowling Green, Ohio. |
| "Climax," "Rex," "Wyoming" | Warsaw-Wilkinson Co., Warsaw, N. Y. |
| | Wausau Foundry & Machine Co., Wausau, Wis. |
| | Wayne Works, Richmond, Ind. |
| "Defender," "Smith" | White's Sons, S. R., Norfolk, Va. |
| "Comet," "Swiss," "Whirlwind" | Wilder-Strong Implement Co., Monroe, Mich. |
| "Gem" | Wilson Brothers, Easton, Pa. |

## FIRE ALARMS

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Aero Alarm Company, New York, N. Y. |
| "Derby" | American Fire Prevention Bureau, New York, N. Y. |
| | Atmo Signal Corporation, Nutley, N. J. |
| | Auth Electric Specialty Co., New York, N. Y. |
| | Autocall Company, Shelby, Ohio |
| "Beeke," "Falcon," "Jove," "Jupitor," "National," "Vulcan," | Bunnell & Company, J. H., New York, N. Y. |
| | Edwards & Company, New York, N. Y. |
| "Schwarze" | Electrical Sales Company, Boston, Mass. |
| | Electroalarm Company, Hutchinson, Minn. |
| | Federal Electric Company, Chicago, Ill. |
| | Foote, Pierson & Company, New York, N. Y. |
| | Gamewell Fire Alarm Telephone Co., Newton Upper Falls, Mass. |
| | Garl Electric Company, Akron, Ohio |
| | Holtzer-Cabot Electric Co., Boston, Mass. |
| | Loper Fire Alarm Company, Stonington, Conn. |
| | Manhattan Electrical Supply Co., New York, N. Y. |
| | McFell Signal Company, Chicago, Ill. |
| "Air Alarm," "Hess" | Metropolitan Electric Protective Asso., New York, N. Y. |
| | Mohawk Electric Mfg. Co., Newark, N. J. |
| "Monitor Detector" | New York Brass Foundry Co., New York, N. Y. |
| | Ostrander & Company, W. R., New York, N. Y. |
| "Reichel" | Pacific Fire Extinguisher Co., San Francisco, Cal. |
| | Partrick & Wilkins Co., Philadelphia, Pa. |
| "Ideal" | Rele Equipment Corp., New York, N. Y. |
| | Samson Electric Co., Canton, Mass |
| | Special Fire Alarm Electrical Signal Co., New York, N. Y. |
| | Standard Electric Time Co., Springfield, Mass. |
| "Faraday" | Stanley & Patterson, New York, N. Y. |
| | Stewart & Company, S. A., Waltham, Mass. |
| | Tele-Call Company, Cleveland, Ohio |
| | United States Automatic Fire Alarm Co., Kansas City, Mo. |
| | Usem Company, New York, N. Y. |
| | Utica Fire Alarm Telegraph Co., Utica, N. Y. |

## FIRE EXTINGUISHERS

| Trade Name | Name and Address of Manufacturer |
|---|---|
| "Pronto" | Allen Corporation, New York, N. Y. |
| "Keystone," "Paragon," | American-LaFrance Fire Engine Co., Elmira, N. Y. |
| "Mitchell," Wisconsin" | Badger Chemical Mfg. Co., Milwaukee, Wis. |
| | Badger Fire Extinguisher Co., Boston, Mass. |
| | Badger & Sons Company, Boston, Mass. |
| "Ecuarusni," "Niagara" | Buffalo Chemical Fire Extinguisher Co., Buffalo, N. Y. |
| **"Utica"** | **Childs Company, O. J., Utica, N. Y.** |
| | Diener Manufacturing Co., Chicago, Ill. |
| | Federal Chemical Works, Minneapolis, Minn. |
| | Feumort Manufacturing Company, New York, N. Y. |
| "Cleveland" | Fire Equipment & Marine Supply Co., Cleveland, Ohio. |
| | Fire Fighting Devices Company, New York, N. Y. |
| | Fire Gun Manufacturing Co., New York, N. Y. |
| | Fire-Out Manufacturing Co., Philadelphia, Pa. |
| | Firex Manufacturing Co., Chicago, Ill. |
| | Foamite Firefoam Company, New York, N. Y. |
| | Fyr-Fyter Company, Dayton, Ohio. |
| | Gammeter-Brodbeck Sales Company, Akron, Ohio. |
| | General Manufacturing Co., St. Louis, Mo. |
| "Wonder Worker" | Hall-Thompson Co., Hartford, Conn. |
| "Queen" | Harker Manufacturing Co., Cincinnati, Ohio. |
| "Eclipse" | Haverhill Fire Appliance Co., Haverhill, Mass. |
| "J-M," "J-M Success," "Manville" | Johns-Manville Company, New York, N. Y. |
| | Knight & Thomas, Boston, Mass. |
| | La May Manufacturing Co., Rochester, N. Y. |
| | Liberty Chemical Works, Chicago, Ill. |
| | Minimax Company, New York, N. Y. |
| | New York Brass Foundry Co., New York, N. Y. |
| "Atlas" | Northern Fire Apparatus Co., Minneapolis, Minn. |
| "Fire-Fly" | Northwestern Chemical Co., Marietta, Ohio. |
| "Deluge" | Prospect Manufacturing Co., Prospect, Ohio. |

## FIRE EXTINGUISHERS (Continued)

| Trade Name | Name and Address of Manufacturers |
|---|---|
| "Guardene" | Pyrene Manufacturing Co., New York, N. Y. |
| | Racine Iron & Wire Works, Racine, Wis. |
| "Ever-Ready" | Republic Chemical Fire Engine Co., Urbana, Ohio. |
| "Acme," "Regina," "Victor" | Rex-Harris Fire Appliance Co. of N. Y., New York, N. Y. |
| | Safety Fire Extinguisher Co., New York, N. Y. |
| | Silvers Manufacturing Company, Waterloo, Iowa. |
| | Standard Extinguisher Co., Boston, Mass. |
| | Stempel Fire Extinguisher Co., St. Louis, Mo. |
| "Auto-Fyr" | U. S. Fire Extinguisher Co., Syracuse, N. Y. |
| "U. S." | United Manufacturing Company, Toledo, Ohio. |

## FLOOD LIGHTS

| | |
|---|---|
| | Benjamin Electric Mfg. Co., Chicago, Ill. |
| "Crescent" | Brenkert Light Projection Co., Detroit, Mich. |
| | Brink, Inc., C. I., Boston, Mass. |
| | Crouse-Hinds Co., Syracuse, N. Y. |
| "Crystal Mirror," "Golden Glow" | Electric Service Supplies Co., Philadelphia, Pa. |
| | Fowler Lamp & Mfg. Co., Chicago, Ill. |
| | General Electric Co., Schenectady, N. Y. |
| | Hallberg, J. H., New York, N. Y. |
| | Harter Mfg. Co., Chicago, Ill. |
| | Liberty Appliance Corp., 249 E. 43rd St., New York. |
| | Milburn Co., A., Baltimore, Md. |
| "X-Ray" | National X-Ray Reflector Co., Chicago, Ill. |
| | Newton, C. I., 305 W. 15th St., New York. |
| | Pyle-National Co., Chicago, Ill. |
| "Flood-O-Lite" | Reflector & Illuminating Co., Chicago, Ill. |
| | Sperry Gyroscope Co., Manhattan Bridge Plaza, New York. |
| "Star" | Star Headlight & Lantern Co., Rochester, N. Y. |
| | Sunbeam Electric Mfg. Co., Evansville, Ind. |
| "Daylight Flood," "Midnight Sun," | Universal Electric Stage Lighting Co., 240 W. 50th St., New York. |
| | Williams, Brown & Earle, Inc., Philadelphia, Pa. |

## FREEZERS, ELECTRIC

| | |
|---|---|
| | Dewsberry, R. A., Chicago, Ill. |
| | Edmonds, W. S., Boston, Mass. |
| | Emery Thompson Machine & Supply Co., New York, N. Y. |
| "Little Giant" | Lange, H. G., Chicago, Ill. |
| "Advance," "Dana," "Eureka," "Excelsior," "Monitor," | Mills & Brother, Philadelphia, Pa. |
| | Peerless Freezer Co., Winchendon, Mass. |
| | Taylor Brothers Churn & Mfg. Co., St. Louis, Mo. |
| | Whitney Co., F. E., Boston, Mass. |

## FUSES, ELECTRIC

| | |
|---|---|
| | American Carbon & Battery Co., East St. Louis, Mo. |
| "Eveready" | American Ever Ready Works of National Carbon Co., L. I. City, N. Y. |
| "Arrowtype" | Arrow Electric Company, Hartford, Conn. |
| "Midget" | Bailey Company, W. J., Newark, N. J. |
| "B. & B." | Betts & Betts Corporation, New York, N. Y. |
| "Pyralite" | Bryant Electric Company, Bridgeport, Conn. |
| "Fire Fly" | Burleigh, George K., Penacook, N. H. |
| "Buss" | Bussmann Mfg. Co., St. Louis, Mo. |
| "Shawmut" | Chase-Shawmut Co., Newburyport, Mass. |
| "Chelton Phila" | Chelten Electric Company, Philadelphia, Pa. |
| "Union" | Chicago Fuse Mfg. Co., Chicago, Ill. |
| | Commercial Enclosed Fuse Co., Hoboken, N. J. |
| | Connecticut Electric Mfg. Co., Bridgeport, Conn. |
| "Koo Lee" | Cooley Mfg. Co., New York, N. Y. |
| | Cote Brothers Mfg. Co., Chicago, Ill. |
| "Ideal" | Daum, A. F., Pittsburgh, Pa. |
| | D. & W. Fuse Works of General Electric Co., Providence, R. I. |
| | Delta Electric Company, Marion, Ind. |
| | Diamond Electric Specialties Corp., Newark, N. J. |
| | Dressel Manufacturing Corp., New York, N. Y. |
| "Arkless," "Clearsite" | Economy Fuse & Mfg. Co., Chicago, Ill. |
| | Electric Fuseguard Company, Newark, N. J. |

## FUSES, ELECTRIC (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| "Service" | Elliott Electric Company, Shreveport, La. |
| | Essex Mfg. Company, Newark, N. J. |
| "National" | Federal Electric Company, Chicago, Ill. |
| | Federal Sign System, Chicago, Ill. |
| | Franco Electric Corp., Brooklyn, N. Y. |
| | General Electric Co., Schenectady, N. Y. |
| | Great Western Refillable Fuse Co., Pittsburgh, Pa. |
| | Grether Fire Equipment Co., Dayton, Ohio |
| "Fuselite" | Hart & Hegeman Mfg. Co., Hartford, Conn. |
| "Hipco" | Hipwell Manufacturing Co., Pittsburgh, Pa. |
| | Imperial Electric Co., Akron, Ohio |
| "Ieco Sixfuse" | Industrial Engineering Co., Detroit, Mich. |
| "Noark" | Johns-Manville Company, New York, N. Y. |
| | Killark Electric Mfg. Co., St. Louis, Mo. |
| | Kilo Instrument Company, Indianapolis, Ind. |
| "K. E." | Kirkman Engineering Corp., New York, N. Y. |
| "Yankee" | Metropolitan Electric Mfg. Co., Long Island City, N. Y. |
| | Monarch Re-Fillable Fuse Co., Jamestown, N. Y. |
| | Moss-Schury Mfg. Co., Detroit, Mich |
| "Atlas," "Four-in-one," "Six-in-one" | Multiple Electric Products Co., New York, N. Y. |
| "Tower" | Oettinger Corporation, F. W., New York, N. Y. |
| | Peerless Refill Fuse Co., Rochester, N. Y |
| "Chief" | Perfect Refillable Fuse Co., Brooklyn, N. Y. |
| | Pierce Fuse Corp., Buffalo, N. Y. |
| "Simplex" | Powell, F. W., Pittsburgh, Pa. |
| | Portex Fuse Works, Cleveland, Ohio |
| | Ree-nu-it Electric Co., New Bedford, Mass. |
| | Reliable Electric Company, Chicago, Ill. |
| | Reliable Electric Company, Chicago, Ill. |
| "Safe-T" | Safety Fuse Handle Co., Woodhaven, L. I. |
| "Sand C" | Schweitzer and Conrad, Inc., Chicago, Ill. |
| | Snow & Company, E. W., Rochester, N. Y. |
| | Southern Electric Manufacturing Co., Bristol, Conn. |
| | Star Fuse Company, New York, N. Y. |
| "Tecco" | Trenton Electric & Conduit Co., Trenton, N. J. |
| | Trico Fuse Manufacturing Co., Milwaukee, Wis. |
| | Trumbull-Vanderpoel Electric Mfg. Co., Bantam, Conn. |
| | United Electric Supply Company, Brooklyn, N. Y. |
| | Union Electric Company, Trenton, N. J. |
| | United States Fuse Company Buffalo, N. Y. |
| | Volk Manufacturing Company, Bantam, Conn. |
| | Ward Electric Company, Philadelphia, Pa. |
| | **Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.** |

## FUSES, CARTRIDGE

| | |
|---|---|
| | Ajax Electric Company, Jersey City, N. J. |
| "Buss" | Bussman Manufacturing Co., St. Louis, Mo. |
| "Shawmut" | Chase-Shawmut Company, Newburyport, Mass. |
| "Union" | Chicago Fuse Manufacturing Co., Chicago, Ill. |
| | D & W Fuse Works of General Electric Co., Providence, R. I. |
| "Arkless" | Economy Fuse & Manufacturing Co., Chicago, Ill. |
| | Federal Electric Company, Chicago, Ill. |
| "Atlas" | Multiple Electric Products Co., Inc., New York, N. J. |
| "Snow" | Snow & Company, E. W., Rochester, N. Y. |
| | United States Fuse Company, Buffalo, N. Y. |
| "Victor" | Volk Manufacturing Company, Westport, Conn. |
| | **Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.** |
| | Windman-Goldsmith, Inc., Perth Amboy, N. J. |

## GENERATORS

| | |
|---|---|
| | **Allis-Chalmers Mfg. Co., Milwaukee, Wis.** |
| | Becker Electric Wks., Chicago, Ill. |
| | Burke Electric Co., Erie, Pa. |
| | Chandeysson Electric Co., St. Louis, Mo. |
| "Willey" | Clark, Jr., Electric Co., Inc., Louisville, Ky. |
| "Colonial" | Colonial Fan & Motor Co., Warren, O. |
| "Comet" | Comet Electric Co., Indianapolis, Ind. |
| "King Edward" | Consolidated Electric Co., Ltd., Toronto, Can. |

## GENERATORS (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Cosby Electric & Machine Co., Richmond, Va. |
| | Crocker-Wheeler Co., Ampere, N. J. |
| | Diehl Mfg. Co., Elizabethport, N. J. |
| "High-Grade" | Eck Dynamo & Motor Co., Belleville, N. J. |
| "Edco" | Electro Dynamic Co., Bayonne, N. J. |
| | Electromotor Co., Chicago, Ill. |
| | Emerson Electric Mfg. Co., St. Louis, Mo. |
| **"Fairbanks-Morse"** | **Fairbanks, Morse & Co., Chicago, Ill.** |
| | Fidelity Electric Co., Lancaster, Pa. |
| "GE" | General Electric Co., Schenectady, N. Y. |
| "Globe" | Globe Electric Co., Milwaukee, Wis. |
| | Great Lakes Electric Mfg. Co., Chicago, Ill. |
| "HB" | Hobart Brothers Co., Troy, N. Y. |
| "Ideal" | Ideal Electric & Mfg. Co., Mansfield, O. |
| "Imperial" | Imperial Electric Co., Akron, O. |
| | Jantz & Leist Electric Co., Cincinnati, O. |
| | Jones & Moore Electric Co., Ltd., Toronto, Can. |
| "K. & D." | Kendrick & Davis Co., Lebanon, N. H. |
| | Kurz & Root, Appleton, Wis. |
| | Lancashire Dynamo & Motor Co., Ltd., Toronto, Can. |
| | Lister & Co., Ltd., Toronto, Can. |
| | Louisville Electric Mfg. Co., Inc., Louisville, Ky. |
| | Main Electric Co., Cleveland, O. |
| | Marble-Card Electric Co., Gladstone, Mich. |
| "Master" | Master Electric Co., Dayton, O. |
| "Watson" | Mechanical Appliance Co., Milwaukee, Wis. |
| "Northwestern" | Northwestern Mfg. Co., Milwaukee, Wis. |
| "Peerless" | Peerless Electric Co., Warren, O. |
| "Jupitor," "Perfection" | Perfection Storage Battery Co., Chicago, Ill. |
| "Reliance" | Reliance Electric & Engineering Co., Cleveland, O. |
| | Robbins & Myers Co., Springfield, O. |
| | Rochester Electric Products Corp., Rochester, N. Y. |
| "Rothmotors" | Roth Bros. & Co., Chicago, Ill. |
| | Sprague Electric Wks. of General Electric Co., 527 W. 34th St., New York. |
| "Star" | Star Electric Motor Co., Newark, N. J. |
| "Triumph" | Triumph Electric Co., Cincinnati, O. |
| "St. Louis" | Valley Electric Co., St. Louis, Mo. |
| | Wesche Electric Co., B. A., Cincinnati, O. |
| | **Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.** |
| "Superior" | Willey-Wray Electric Co., Cincinnati, O. |

## HYDROMETERS

| Trade Name | Name and Address of Manufacturer |
|---|---|
| "Autocrat" | American Thermo-Ware Co., New York, N. Y. |
| | Armand Machine Works, Chicago, Ill. |
| | Battery Equipment & Supply Co., Chicago, Ill. |
| | Beck & Company, O., Brooklyn, N. Y. |
| "Master," Radiatometer" | Beckley-Ralston Co., Chicago, Ill. |
| | Dossman Accessory Company, Cincinnati, Ohio. |
| "Breaknot," "Testometer" | Edelmann & Company, E., Chicago, Ill. |
| "Genco" | General Scientific Equipment Co., Philadelphia, Pa. |
| | Griebel Instrument Company, Carbondale, Pa. |
| | Luthy Hydrometer Company, Detroit, Mich. |
| "A. E. M." | Moeller, A. E., Brooklyn, N. Y. |
| "Test Right" | Optical Specialities Co., New York, N. Y. |
| | Perfection Hydrometer Company, Los Angeles, Calif. |
| | Queen-Gray Company, Philadelphia, Pa. |
| | Rieker Instrument Co., Philadelphia, Pa. |
| "Kant Stick," "Reliable," Simplex" | Scranton Glass Instrument Co., Scranton, Pa. |
| "Stadco" | Stadeker Metal Specialty Co., Chicago, Ill. |
| "Hydrokit," "Wintometer" | Steiner Mfg. Co., Long Isand City, N. Y. |
| | Storage Battery Supply Co., New York, N. Y. |
| | Tagliabue Manufacturing Co., C. J. Brooklyn, N. Y. |
| "Freezometer" | Taylor Instrument Companies, Rochester, N. Y. |
| "Dependable" | Universal Products Co., Chicago, Ill. |
| | Weinhagen & Hespe, New York, N. Y. |
| | Weiss & Son, Brooklyn, N. Y. |
| | Workrite Manufacturing Company, Cleveland, Ohio. |

## IGNITION EQUIPMENT

### Contact Points

| Trade Name | Name and Address of Manufacturer |
|---|---|
| "Con-Tac-Tor" | Absolute Con-Tac-Tor Co., Chicago, Ill. |
| | American Platinum Wks., Newark, N. J. |
| | Baker & Co., Inc., Newark, N. J. |
| | Bishop & Co., Malvern, Pa. |
| "Comreco" | Commercial Research Co., 18 E. 41st St., New York. |
| | Eastern Precision Electrical Instrument Co., Rockville Center, N. Y. |
| | Eby Mfg. Co., H. H., Philadelphia, Pa. |
| | Elkon Wks. of General Electric Co., Weehawken, N. J. |
| | Fansteel Products Co., Inc., N. Chicago, Ill. |
| | Foote Mineral Co., Philadelphia, Pa. |
| | Gilfillan Bros., Inc., Los Angeles, Cal. |
| | Handy & Harman, 59 Cedar St., New York. |
| | Independent Lamp & Wire Co., 1737 Bway., New York. |
| | Klitzen Radio Mfg. Co., Inc., Racine, Wis. |
| "K-W" | K-W Ignition Co., Cleveland, Ohio. |
| | Liberty Electric Corp., Port Chester, N. Y. |
| | Niehoff & Co., Inc., Chicago, Ill. |
| | Pick Mfg. Co., R., Chicago, Ill. |
| | Waterbury Button Co., Waterbury, Conn. |
| "Wilco" | Wilson Co., H. A., Newark, N. J. |
| | Wolverine Motor Wks., Bridgeport, Conn. |

### Magnetos

| | |
|---|---|
| "Bosch" | American Bosch Magneto Corp., Springfield, Mass. |
| "Swiss" | American Swiss Magneto Co., Toledo, Ohio. |
| | Apollo Magneto Company, Kingston, N. Y. |
| "Liberty" | Berkshire Magneto Company, Pittsfield, Mass. |
| | Eisemann Magneto Corporation, Brooklyn, N. Y. |
| "Berling" | Ericsson Manufacturing Co., Buffalo, N. Y. |
| "Heco" | Heinze Electric Company, Lowell, Mass. |
| | K-W Ignition Company, Cleveland, Ohio. |
| "Kingstan" | Kokomo Electric Company, Kokomo, Ind. |
| | Lauraine Magneto Company, Long Island City, N. Y. |
| | Motsinger Device Manufacturing Co., Lafayette, Ind. |
| | National Coil Company, Lansing, Mich. |
| "Natco" | National Ignition Company, Irvington-on-Hudson, N. J. |
| "Ohmer" | Recording & Computing Machine Co., Dayton, Ohio. |
| | Remy Electric Company, Detroit, Mich. |
| | **Simms Magneto Company, East Orange, N. J.** |
| | Simplex Magneto Company, New York, N. Y. |
| | Splitdorf Electrical Company, Newark, N. J. |
| | Standard Ignition Company, Elkhart, Ind. |
| | Teagle Company, Cleveland, Ohio. |
| "Rogers" | Vita Manufacturing Co., Cleveland, Ohio. |

### Spark Coils

| | |
|---|---|
| | Acme Wire Co., New Haven, Conn. |
| "Paragon" | Adams Morgan Co., Upper Montclair, N. J. |
| "Bosch" | American Bosch Magneto Corp., Springfield, Mass. |
| | American Radio & Research Corp., 21 Park Row, New York. |
| | Apollo Magneto Corp., Kingston, N. Y. |
| | American Coil Co., Foxboro, Mass. |
| | Becker Electric Wks., Chicago, Ill. |
| "Bee Cee" | Brown & Caine, Chicago, Ill. |
| "Canadian" | Canadian Coil Co., Ltd., Walkerville, Can. |
| "Connecticut" | Connecticut Telephone & Electric Co., Meriden, Conn. |
| "Detroit" | Detroit Coil Co., Detroit, Mich. |
| "Bushkill" | Doyle-Dacosta Mfg. Co., Easton, Pa. |
| | Dudlo Mfg. Co., Ft. Wayne, Ind. |
| "Pemko" | Eastern Parts Mfg. Co., Inc., 135 Spring St., New York. |
| | Eby Mfg. Co., H. H., Philadelphia, Pa. |
| | Eisemann Magneto Corp., Brooklyn, N. Y. |
| | Fansteel Products Co., N. Chicago, Ill. |
| | Goldberg Ozone Machine Co., Indianapolis, Ind. |
| "Sturdy" | Gray-Heath Co., Chicago, Ill. |
| "Heco" | Heinze Electric Co., Lowell, Mass. |

## IGNITION EQUIPMENT

### Spark Coils (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Hercules Mfg. Co., Indianapolis, Ind. |
| "J & B" | J & B Mfg. Co., Pittsfield, Mass. |
| | Jefferson Electric Co., Chicago, Ill. |
| | K-W Ignition Co., Cleveland, Ohio. |
| "Kingston" | Kokomo Electric Co., Kokomo, Ind. |
| | Lemke Electric Co., Milwaukee, Wis. |
| "Mesco" | Manhattan Electrical Supply Co., 17 Park Place, New York. |
| | Marion Electrical Mfg. Co., Jersey City, N. J. |
| "Miller Hi-Speed" | Miller & Johnson Auto Electric Co., Los Angeles, Cal. |
| | Millwood-Bracket Co., Des Moines, Ia. |
| | National Coil Co., Lansing, Mich. |
| | New York Coil Co., 338 Pearl St., New York. |
| | Niehoff & Co., Inc., Chicago, Ill. |
| "Berkshire," "Jewell," "Micatite" | Pittsfield Spark Coil Co., Pittsfield, Mass. |
| "Quick Action" | Quick Action Ignition Co., South Bend, Ind. |
| "Ohmer" | Recording & Computing Machines Co., Dayton, Ohio. |
| | Remy Electric Co., Anderson, Ind. |
| | Samson Electric Co., Canton, Mass. |
| | Simek & Co., 15 Park Row, New York. |
| | Spencer Metal Products Co., Spencer, Ohio. |
| | Splitdorf Electrical Co., 98 Warren St., New York. |
| | Thordarson Electric Mfg. Co., Chicago, Ill. |
| | Wells Mfg. Co., R. C., Fond Du Lac, Wis. |
| | Williams, E. Q., Syracuse, N. Y. |

### Spark Plugs

| Trade Name | Name and Address of Manufacturer |
|---|---|
| "Bosch" | American Bosch Magneto Corporation, Springfield, Mass. |
| "Red Chief" | American Manufacturing Company, Evansville, Indiana. |
| "Hasteel" | Anderson Spark Plug Company, Chicago, Illinois. |
| | Arco-O Manufacturing Company, Chicago, Illinois. |
| "Blazer" | Auburn Ignition Manufacturing Company, Richmond, Indiana. |
| "Golden Eagle" | Benford Auto Products, Inc., Mount Vernon, New York. |
| "Golden Giant" | Benford Auto Products, Inc., Mount Vernon, New York. |
| "Monarch" | Benford Auto Products, Inc., Mount Vernon, New York |
| "White Cap" | Benford Auto Products, Inc., Mount Vernon, New York. |
| "Bingham Perfected" | Bingham Perfected Spark Plugs, Rockford, Illinois. |
| "Liberty" | Casey-Hudson Company, Chicago, Illinois. |
| "United" | Casey-Hudson Company, Chicago, Illinois. |
| | Chain-O-Spark Company, Minneapolis, Minnesota. |
| "A. C." | Champion Ignition Company, Flint, Michigan. |
| "Cico" | Champion Ignition Company, Flint, Michigan. |
| "Titan" | Champion Ignition Company, Flint, Michigan. |
| "Ajax" | Champion Spark Plug Company, Toledo, Ohio. |
| "J-D" | Champion Spark Plug Company, Toledo, Ohio. |
| "Meteor" | Champion Spark Plug Company, Toledo, Ohio. |
| "Reliance" | Champion Spark Plug Company, Toledo, Ohio. |
| "Star" | Champion Spark Plug Company, Toledo, Ohio. |
| "Sta-Rite" | Champion Spark Plug Company, Toledo, Ohio. |
| "Ace" | Comet Manufacturing Company, Dayton, Ohio. |
| "Dico" | Dayton Ignition Company, Dayton, Ohio. |
| | Dearborn Equipment Company, Kalamazoo, Michigan. |
| "Derf" | Derf Manufacturing Company, New York, N. Y. |
| "X-L" | Excelsior Leather Washer Mfg. Co., Rockford, Illinois. |
| "Red Seal" | J. H. Faw Company, New York, N. Y. |
| "Eklips" | Fulton Company, Milwaukee, Wisconsin. |
| "Wizard" | Hampshire Mfg. Company, Hatfield, Mass. |
| "H. M. S. Bull Dog" | Hartford Machine Screw Company, Hartford, Conn. |
| "Bougie Mercedes" | Herz, New York, N. Y. |
| "Man-O-War" | Hi-Power Spark Plug Company, St. Louis, Mo. |
| | Ignition Company of America, Port Jervis, N. Y. |
| "Eagle" | Janesville Products Company, Janesville, Wis. |
| "X-L" | Janesville Products Company, Janesville, Wis. |
| "Kant-Mis" | Kant-Mis Spark Plug Company, Green Bay, Wis. |
| "Kingston" | Kokomo Electric Company, Kokomo, Indiana. |
| | Laurine Magneto Company, Long Island City, N. Y. |
| "New Departure" | Marvel Manufacturing Company, Bridgeport, Conn. |

## IGNITION EQUIPMENT

### Spark Plugs (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Morgan Manufacturing Company, Keen, New Hampshire. |
| "Liberty" | A. R. Mosler & Company, Mount Vernon, N. Y. |
| "Superior" | A. R. Mosler & Company, Mount Vernon, N. Y. |
| "Triumph" | A. R. Mosler & Company, Mount Vernon, N. Y. |
| "Vesuvius" | A. R. Mosler & Company, Mount Vernon, N. Y. |
| "Pyramid" | National Manufacturing Utilities Co., Chicago, Ill. |
| "Northwind" | Northwind Spark Plug Corporation, New York, N. Y. |
| "Blitz" | Randall-Faichney Company, Boston, Mass. |
| | Red Line, Inc., Grand Rapids, Michigan. |
| "Arrow" | Reflex Ignition Company, Cleveland, Ohio. |
| "Baby" | Reflex Ignition Company, Cleveland, Ohio. |
| "Diamond" | Reflex Ignition Company, Cleveland, Ohio. |
| "Giant" | Reflex Ignition Company, Cleveland, Ohio. |
| "Kid" | Reflex Ignition Company, Cleveland, Ohio. |
| "Lightning" | Reflex Ignition Company, Cleveland, Ohio. |
| "Rex" | Rex Ignition Manufacturing Company, New York, N. Y. |
| "Rosco" | A. W. Rosen & Company, New York, N. Y. |
| | S. & M. Manufacturing Company, Pittsburgh, Pa. |
| "V-Ray" | Stewart-Warner Speedometer Corp., Chicago, Illinois. |
| "Tungsten" | Tungsten Manufacturing Company, Marshalltown, Iowa. |
| "V-D" | Viktry Sales Company, Milwaukee, Wisconsin. |
| "Durabilt" | W. H. S. Manufacturing Company, Indianapolis, Indiana. |
| "Fyresm" | Wellman-Muter Corp., Chicago, Illinois. |
| | Western Screw Products Company, St. Louis, Mo. |
| | Whitaker Manufacturing Company, Chicago, Illinois. |

### Timers

| | |
|---|---|
| | Almy Water Tube Boiler Co., Providence, R. I. |
| | Boicourt-Lopez Mfg. Co., San Antonio, Texas. |
| "Star" | Capitol Tool & Die Wks., Chicago, Ill. |
| | Connecticut Telephone & Electric Co., Meriden, Conn. |
| | Cuno Engineering Corp., Meriden, Conn. |
| "Gladiator" | Gladiator Mfg. Co., Auburn, Ind. |
| "Heco" | Heinze Electric Co., Lowell, Mass. |
| | Herz, 182 Locust Ave., New York. |
| | Howe Lamp & Mfg. Co., Chicago, Ill. |
| "J & B" | J & B Mfg. Co., Pittsfield, Mass. |
| | Lundgren Mfg. Co., Philadelphia, Pa. |
| | McCulloch Mfg. Co., Boston, Mass. |
| "Milwaukee" | Milwaukee Auto Engine & Supply Co., Milwaukee, Wis. |
| | Modern Tool & Stamping Co., Chicago, Ill. |
| "K-L" | M-R Co., Lincoln, Neb. |
| "Rhoades" | New York Coil Co., 340 Pearl St. New York. |
| | Niehoff & Co., Inc., Chicago, Ill. |
| | Splitdorf Electrical Co., Newark, N. J. |
| "Sintz" | Wilmarth & Morman Co., Grand Rapids, Mich. |
| | X-Cell-All Co., Chicago, Ill. |

## INCUBATORS AND BROODERS

| | |
|---|---|
| | Axford Incubator Company, Chicago, Ill. |
| | Banta & Bender Company, Ligonier, Ind. |
| "Belle City" | Belle City Incubator Company, Racine, Wis. |
| "Champion" | Bennett & Son, J. A., Gouverneur, N. Y. |
| "Bantam" | Buckeye Incubator Co., Springfield, Ohio. |
| "Buckeye" | Buckeye Incubator Co., Springfield, Ohio. |
| | Buffalo Incubator Company, Buffalo, N. Y. |
| | Burr Incubator Company, Omaha, Neb. |
| | Cabinet Manufacturing Company, Quincy, Ill. |
| | Candel Incubator & Brooder Co., Eastwood, N. Y. |
| | Croley Company, G. H., San Francisco, Calif. |
| | Cycle Hatcher Company, Elmira, N. Y. |
| | Cyphers Incubator Company, Buffalo, N. Y. |
| "Crescent" | Des Moines Incubator Co., Des Moines, Iowa. |
| "Eclipse" | Des Moines Incubator Co., Des Moines, Iowa. |
| "Successful" | Des Moines Incubator Co., Des Moines, Iowa. |

## INCUBATORS AND BROODERS (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| *"Lectro-Brood" | Electric Controller Co., Indianapolis, Ind. |
| "Lectro-Hatch" | Electric Controller Co., Indianapolis, Ind. |
| "Hatching Wonder" | Ertel Company, G., Quincy, Ill. |
| "Improved Victor" | Ertel Company, G., Quincy, Ill. |
| "Poor Man's Friend" | Ertel Company, G., Quincy, Ill. |
| | Essex Incubator Company, Buffalo, N. Y. |
| "Sure Hatch" | Fremont Manufacturing Company, Fremont, Neb. |
| | Gem Manufacturing Company, Greenville, Ohio. |
| | Hall Mammoth Incubator Company, Little Falls, N. Y. |
| "Peep-O-Day" | Hodgson Company, E. F., Boston, Mass. |
| | Humphreys & Sons, Joliet, Ill. |
| "None-Such" | Indianapolis Corrugating Co., Indianapolis, Ind. |
| "Simplicity" | Indianapolis Corrugating Co., Indianapolis, Ind. |
| "Ironclad" | Ironclad Incubator Co., Racine, Wis. |
| | Johnson Company, M. M., Clay Centre, Neb. |
| "Great Western" | Jones, Post & Company, Racine, Wis. |
| "Klondike" | Klondike Incubator Company, Des Moines, Iowa. |
| "Favorite" | Leahy Manufacturing Co., Higginsville, Mo. |
| *"Reed's" | Liberty Manufacturing Co., New Orleans, La. |
| ***"Lo-Glo"** | **Lo-Glo Incubator Company, New York, N. Y.** |
| | Manson-Campbell & Sons Company, Detroit, Mich. |
| | Merryman, S. H., Towson, Md. |
| | Miller Company, J. W., Rockford, Ill. |
| "Milcoe" | Milwaukee Corrugating Company, Milwaukee, Wis. |
| | Model Incubator Company, Buffalo, N. Y. |
| | National Incubator Company, Racine, Wis. |
| "Fairfield" | Nebraska Incubator Company, Fairfield, Neb. |
| | Neubert Company, R. F., Mankato, Minn. |
| | Northwestern Stamping Company, Burlington, Ia. |
| | **Oakes Manufacturing Company, Tipton, Ind.** |
| | Petaluma Incubator Company, Petaluma, Calif. |
| | Phillips, Oliver P., Amo, Ind. |
| | Prairie State Incubator Company, Homer City, Pa. |
| "Racine" | Progressive Incubator Company, Racine, Wis. |
| | Queen Incubator Company, Lincoln, Neb. |
| "Rayo" | Rayo Incubator Company, Omaha, Neb. |
| | Reeves Manufacturing Company, Dover, Ohio. |
| | Reliable Incubator & Brooder Co., Quincy, Ill. |
| "Peerless" | Sheer Company, H. M., Quincy, Ill. |
| "Spokane" | Spokane Incubator Co., Spokane, Wash. |
| | Springfield Incubator Co., Springfield, Ohio. |
| "Excelsior" | Stahl, G. H., Quincy, Ill. |
| "Sure Hatch" | Sure Hatch Incubator Company, Fremont, Neb. |
| | Uhl & Company, M., New Washington, Ohio. |
| | Watson Manufacturing Company, Lancaster, Pa. |
| | Weimer, A., Ligonier, Ind. |
| | Wisconsin Incubator Company, Racine, Wis. |

*Manufacture Electric types incubators and brooders.

## INSULATING TAPE

| | |
|---|---|
| "Apex" | Anchor Packing Company, New York, N. Y. |
| "Awebco" | Anchor Webbing Company, Pawtucket, R. I. |
| "Evergrip" | Boston Woven Hose & Rubber Co., Cambridge, Mass. |
| | Clifton Manufacturing Company, Boston, Mass. |
| | Gilmer Company, Philadelphia, Penna. |
| | B. F. Goodrich Company, Akron, Ohio. |
| | Hudson Narrow Fabric Company, Hudson, Mass. |
| | Indiana Rubber and Insulated Wire Co., Jonesboro, Ind. |
| "J-M" | Johns-Manville Company, New York, N. Y. |
| | Ketire Insulated Wire and Cable Co., New York, N. Y. |
| | Multibestos Company, Walpole, Mass. |
| "Red Cross" | National Rubber and Specialties Co., Cincinnati, Ohio. |
| | New York Insulated Wire Co., New York, N. Y. |
| "Manson" | Okonite Company, Passaic, N. J. |
| "Rusco" | Russell Manufacturing Company, Middletown, Conn. |
| "Bestyet" | Saint Louis Rubber Cement Co., Saint Louis, Mo. |

## INSULATING TAPE (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Smith Belting Company, Philadelphia, Pa. |
| | United States Tire Company, New York, N. Y. |
| | Van Cleef Brothers, Chicago, Ill. |
| | **Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.** |
| | Wood Manufacturing Company, New York, N. Y. |

## INSULATORS

### Battery and Electrolytic Insulators

| | |
|---|---|
| | Good Mfg. Co., Chicago, Ill. |
| | Hopewell Insulation & Mfg. Co., Inc., Hopewell, Va. |
| "I. O. C." | International Oxygen Co., Newark, N. J. |

### Fixture Insulators

| | |
|---|---|
| | Best Electric Corp., 476 Broadway, New York. |
| | Brandywine Fibre Products Co., Wilmington, Del. |
| | Hopewell Insulation & Mfg. Co., Inc., Hopewell, Va. |
| | International Insulating Corp., 25 W. 45th St., New York. |
| | Macallen Co., Boston, Mass. |

### Glass Insulators

| | |
|---|---|
| "Hemingray" | Hemingray Glass Co., Muncie, Ind. |
| | Joslyn Mfg. & Supply Co., Chicago, Ill. |
| | Locke, F. M., Victor, N. Y. |
| | **Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.** |

### Swinging Insulators

| | |
|---|---|
| | Hopewell Insulation & Mfg. Co., Inc., Hopewell, Va. |
| "Victor" | Locke Insulator Corp., Baltimore, Md. |
| | St. Louis Malleable Casting Co., St. Louis, Mo. |
| "Thomas" | Thomas & Sons Co., R., E. Liverpool, Ohio. |

### Tree Insulators

| | |
|---|---|
| | Cutter, S. C., Oswego, Ill. |
| | Estes & Sons, E. B., 362 Fifth Ave., New York. |
| | Fletcher Mfg. Co., Dayton, Ohio. |
| | Great Lakes Radio Supplies Co., Inc., Elmhurst, Ill. |
| "Holmes" | High Tension Electrical Specialty Co., Newton, Mass. |
| ; | Hopewell Insulation & Mfg. Co., Hopewell, Va. |
| "Peirce" | Hubbard & Co., Pittsburgh, Pa. |
| | Line Material Co., South Milwaukee, Wis. |
| | Locke, F. M., Victor, N. Y. |
| "O-B" | Ohio Brass Co., Mansfield, Ohio. |
| "Thomas" | Thomas & Sons Co., E. Liverpool, Ohio. |
| | **Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.** |

## INSULATOR CLAMPS

| | |
|---|---|
| | Anderson Mfg. Co., A. & J., Boston, Mass. |
| | Coombs & Co., R. D., 30 Church St., New York. |
| | Delta-Star Electric Co., Chicago, Ill. |
| "Efficiency" | Efficiency Electric Co., E. Palestine, Ohio. |
| | Fletcher Mfg. Co., Dayton, Ohio. |
| | General Devices and Fittings Co., Chicago, Ill. |
| "RVA" | Great Lakes Radio Supplies Co., Inc., Elmhurst, Ill. |
| | Hebendahl Co., J. P., Elizabethtown, N. J. |
| "H & S" | Hickep & Schneider, Inc., Elizabeth, N. J. |
| "Hubbard" | Hubbard & Co., Pittsburgh, Pa. |
| | International Insulating Corp., 25 W. 45th St., New York. |
| | Joslyn Mfg. & Supply Co., Chicago, Ill. |
| | Lanz & Sons, M., Pittsburgh, Pa. |
| | Line Material Co., S., Milwaukee, Wis. |
| | Locke Insulator Corp., Baltimore, Md. |
| "Memco" | Maxwell Eng. & Mfg. Co., 61 Bway., New York. |
| | Monarch Electric Co., Ltd., Lambert, Can. |
| | National Co., Boston, Mass. |
| "O-B" | Ohio Brass Co., Mansfield, Ohio. |
| | St. Louis Malleable Casting Co., St. Louis, Mo. |
| | Southern Electrical Equipment Co., Charlotte, N. C. |
| "Thesco" | States Co., Hartford, Conn. |
| "Steel City" | Steel City Electric Co., Pittsburgh, Pa. |
| "Thomas" | Thomas & Sons Co., R., E. Liverpool, Ohio. |
| | **Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.** |

## LAMPS

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Acton Electric Company, Newark, N. J. |
| | Aladdin Appliance Company, Plymouth, Pa. |
| "Excel," "Metalyte" | American Appliance Co., Indianapolis, Ind. |
| | Anthony Wayne Lamp Co., Fort Wayne, Ind. |
| | Apex Electrical Specialty Co., Newark, N. J. |
| "Marvel" | Brite Lite Lamp Manufacturing Co., Providence, R. I. |
| | C-B Electric Company, Boston, Mass. |
| "Champion" | Consolidated Electric Lamp Co. Danvers, Mass. |
| "Edison Mazda" | Edison Lamp Works of General Electric Co., Harrison, N. J. |
| | Eureka Manufacturing Company, Newark, N. J. |
| | Fowler Electric Lamp Co., Philadelphia, Pa. |
| "Linolite" | Frink, I. P., New York, N. Y. |
| "Gico" | General Illuminating Company, Brooklyn, N. Y. |
| "Comet" | General Research Corp., Providence, R. I. |
| "How-Co" | Howland Manufacturing Co., Malden, Mass. |
| | H. & S. Electric Lamp Company, New York, N. Y. |
| | Hygrade Lamp Company, Salem, Mass. |
| | Kentucky Electric Lamp Co., Owensboro, Ky. |
| "Lunar" | Lux Manufacturing Company, Newark, N. J. |
| | Lyhtan Electric Lamp Company, Jersey City, N. J. |
| | Morse, F. W., Boston, Mass. |
| | M. & W. Company, Springfield, Mass. |
| "National Mazda" | National Lamp Works of General Electric Co., Cleveland, Ohio. |
| | New England Electric Lamp Company, Danvers, Mass. |
| | New Jersey Tungsten Lamp Co., Hoboken, N. J. |
| | New York Electric Lamp Company, New York, N. Y. |
| "Nelco," "Opall Snowhite" | Nitrogen Electric Co., Newark, N. J. |
| "Nilco" | Novelty Incandescent Lamp Co., Emporium, Pa. |
| | Safety Electric Company, Chicago, Ill. |
| | Save Electric Corp., Brooklyn, N. Y. |
| | Sunlight Electrical Mfg. Co., Warren, Ohio. |
| | Triumph Lamp Works, Union Hill, N. J. |
| | Lamp Manufacturing Company, New York. |
| "Raolite" | Universal Electric Lamp Co., Newark, N. J. |
| "Tucan" | Weller, F. R., Newark, N. J. |
| **"Westinghouse"** | **Westinghouse Lamp Co., New York** |
| "Dualite" | Whitelite Electric Co., New York. |
| | **Western Electric Co., New York.** |

## LIGHTING FIXTURES

| | |
|---|---|
| | Abco Mfg. Co., Chicago, Ill. |
| "Acmetal" | Acme Lighting Fixture Co., Inc., 132 W. 14th St., New York. |
| | Adam Co., E. C., St. Louis, Mo. |
| | Aladdin Mfg. Co., Muncie, Ind. |
| "Altelite" | Alt-Le Lighting Fixture Co., 252 Bowery, New York. |
| | American Brass & Copper Co., 138 Lafayette St., New York. |
| | Andresen Co., Minneapolis, Minn. |
| | Anodion Metal Co., Baltimore, Md. |
| | Art Craft Fixture Co., Newark, N. J. |
| | Art Craft Metal Stamping Corp., Brooklyn, N. Y. |
| "Alfco" | Artistic Lighting Fixture Corp., 21 E. Houston St., New York. |
| | Bailey-Reynolds Chandelier Co., Kansas City, Mo. |
| | Banfield & Sons, Ltd., Toronto, Can. |
| "B-L" | Bauman & Loeb, Inc., 138 Bowery, New York. |
| | Bayley & Sons, Inc., 105 Vanderveer St., Brooklyn, N. Y. |
| "Beardslee" | Beardslee Chandelier Mfg. Co., Chicago, Ill. |
| "Beaver" | Beaver Machine & Tool Co., Newark, N. J. |
| | Benjamin Electric Mfg. Co., Chicago, Ill. |
| | Beyer & Co., L., Cleveland, Ohio. |
| | Biddle-Gaumer Co., Philadelphia, Pa. |
| | Black & Boyd Mfg. Co., 17 E. 47th St., New York. |
| "Bee-Dee" | Brandt-Dent Co., Watertown, Wis. |
| | Bridgeton Chandelier Co., Bridgeton, N. J. |
| | Buffalo Chandelier Corp., Buffalo, N. Y. |
| | Burtschaell, J. W., San Francisco, Cal. |
| | Caldwell & Co., Inc., 36 W. 15th St., New York. |
| "Duplexalite" | Canadian Duplexalite Co., Montreal, Can. |

## LIGHTING FIXTURES (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| "Cas-O-Lux" | Cassidy Co., Inc., Long Island City, N. Y. |
| | Central Chandelier Co., 224 Centre St., New York. |
| | Central Lighting Fixture Co., Philadelphia, Pa. |
| | Chicago Reedware Mfg. Co., Chicago, Ill. |
| "Artistic Beauty" | Clinton Metal Lamp Co., 55 Chrystie St., New York. |
| | Cole Mfg. Co., Lindsay, Can. |
| | Collins-Wagner Mfg. Co., 122 W. 43rd St., New York. |
| | Colonial Chandelier Wks., Inc., 122 Centre St., New York. |
| | Commercial Lighting Wks., Inc., Chicago, Ill. |
| | Conneaut Metal Wks. Co., Conneaut, Ohio. |
| "Convenolite" | Convenolite Co., N. Chicago, Ill. |
| | Cosby Electric & Machine Co., Richmond, Va. |
| | Crescent Art Metal Co., Bridgeton, N. J. |
| "Crescent" | Crescent Brass Products Co., Cleveland, Ohio. |
| | Crown Chandelier Co., Inc., 610 Bway., New York. |
| | Crown Electrical Mfg. Co., Brantford, Can. |
| | Dale Lighting Fixture Co., Inc., 107 W. 13th St., New York. |
| "1100," "600" | Dallas Brass & Copper Co., Chicago, Ill. |
| | Eastern Brass Wks., Newark, N. J. |
| "Lite Unit" | Edwards Lighting Fixture Co., Chicago, Ill. |
| "Ever So New" | Everson & Co., C. G., Chicago, Ill. |
| | Faries Mfg. Co., Decatur, Ill. |
| "Findlaylite" | Findlay Mfg. Co., Inc., 224 5th Ave, New York. |
| "Perfeclite" | First National Lighting Corp., Cleveland, Ohio. |
| "Frankelite" | Frankel Light Co., Cleveland, Ohio. |
| | Grady Fixture Mfg. Co., M. J., Minneapolis, Minn. |
| | Gross Chandelier Co., St. Louis, Mo. |
| | Handel Co., Meriden, Conn. |
| | Hendrickson Chandelier Mfg. Co., Minneapolis, Minn. |
| | Herwig Art Shade & Lamp Co., Chicago, Ill. |
| "Dek-a-ro" | Highlands Mfg. Co., Muncie, Ind. |
| "Isco" | Incandescent Supply Co., Pittsburgh, Pa. |
| | Interior Lamp & Fixture Wks., Chicago, Ill. |
| "Kayline" | Kayline Co., Cleveland, Ohio. |
| "Lov Lite" | Liberty Lamp & Shade Co., Brooklyn, N. Y. |
| "Lightolier" | Lightolier Co., 569 Bway., New York. |
| "Lincoln" | Lincoln Mfg. Co., Detroit, Mich. |
| | Lion Electrical Appliance Co., Brooklyn, N. Y. |
| "Brascolite," "E-Lite" | Luminous Unit Co., Div. St. Louis Brass Mfg. Co., St. Louis, Mo. |
| "Queens Quality" | McPhilben Lighting Fixture Co., Inc., Queens, N. Y. |
| "Miller" | Miller & Co., E., Meriden, Conn. |
| "Mohrlite" | Mohrlite Co. of America, Nashville, Tenn. |
| "M & H" | Moran & Hastings Mfg. Co., Chicago, Ill. |
| | Moran & MacNair, Inc., Chicago, Ill. |
| | Mutual Metal Mfg. Co., Chicago, Ill. |
| | National Diffused Light Co., Chicago, Ill. |
| "Six-S" | National Lighting Fixture Mfg. Co., 176 Grand St., New York. |
| | National X-Ray Reflector Co., Chicago, Ill. |
| | New England Brass & Fixture Co., Boston, Mass. |
| "Nylco" | New York Lighting Fixture Mfg. Co., 67 Spring St., New York. |
| | Newman Mfg. Co., Cincinnati, Ohio. |
| | Panama Electric Light Co., Inc., Chicago, Ill. |
| "Peerlite" | Peerless Light Co., Chicago, Ill. |
| "Perfeclite" | Perfeclite Mfg. Co., Seattle, Wash. |
| | Phoenix Light Co., Milwaukee, Wis. |
| | Plaut & Co., L., 434 E. 23rd St., New York. |
| | Polly Mfg. Co., Milwaukee, Wis. |
| "Radiant" | Radiant Lighting Fixture Co., Inc., 33 Bleecker St., New York. |
| "Reflectolyte" | Reflectolyte Co., St. Louis, Mo. |
| | Riddle Co., E. N., Toledo, Ohio. |
| | Royal Art Glass Co., 243 Canal St., New York. |
| | St. Charles Fixture Mfg. Co., St. Charles, Ill. |
| | Scott-Ullman Co., Cleveland, Ohio. |
| | Shapiro & Aronson, Inc., 20 Warren St., New York. |
| | Sieffert Electric Co., Evansville, Ind. |
| | Simes Co., 22 W. 15th St., New York. |
| | Snyder-McFadden Co., Sioux City, Ia. |
| "Steko" | Standard Electric & Mfg. Co., Cedar Rapids, Ia. |

## LIGHTING FIXTURES (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Sterling Bronze Co., 201 E. 12th St., New York. |
| | Triangle Chandelier Mfg. Co., Chicago, Ill. |
| "Compolite" | Voigt Co., Philadelphia, Pa. |
| | Wakefield Brass Co., Vermilion, Ohio. |
| | Warren & Co., W. G., Chicago, Ill. |
| "Economy Light" | Whiting Co., Inc., 104 E. 41st St., New York. |
| | Williamson & Co., R., Chicago, Ill. |
| "World" | World Lighting Appliance Co., 136 Bowery, New York. |
| | Wyle & Bros., Inc., 18 E. 27th St., New York. |
| | Young, Inc., L., 214 E. 40th St., New York. |

## LIGHTNING ARRESTERS

| | |
|---|---|
| "Ajax" | Anderson Mfg. Company, A. & J., Boston, Mass. |
| | Arrow Conductor & Manufacturing Co., Chicago, Ill. |
| | Brach Manufacturing Company, L. S., Newark, N. J. |
| | Delta-Star Electric Company, Chicago, Ill. |
| | Electric Service Supplies Company, Philadelphia, Pa. |
| | General Electric Company, Schenectady, N. Y. |
| "Jacobus" | Gifford Electric Mfg. Company, Mich., N. Y. |
| | High Voltage Equipment Co., Cleveland, Ohio |
| "Universal" | Hubbard & Company, Pittsburgh, Pa. |
| | Railway & Industrial Engineering Co., Pittsburgh, Pa. |
| "S. & C." | Schweitzer & Conrad, Chicago, Ill. |
| "Multi-Vapo-Gap" | Shaw Insulator Company, Newark, N. J. |
| | Shield Electric Company, New York, N. Y. |
| | **Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.** |

## LIGHTNING RODS

| | |
|---|---|
| | American Lightning Rod & Cable Co., Omaha, Neb. |
| | American Cable & Mfg. Co., Stanberry, Mo. |
| "Anderson" | Anderson Mfg. Co., Des Moines, Ia. |
| | Bajohr Lightning Conductor Co., St. Louis, Mo. |
| | Barnett & Co., J., Cedar Rapids, Ia. |
| | Beckman Brothers, Des Moines, Ia. |
| | Boston Lightning Rod Co., Boston, Mass. |
| | Burkett Lightning Rod Co., Fremont, O. |
| | Cole Brothers Lightning Rod Co., St. Louis, Mo. |
| | Dallas & Son, A. C., Chicago, Ill. |
| | Des Moines Lightning Rod Co., Des Moines, Ia. |
| | Diamond Cable Co., Bourbon, Ind. |
| "Diddie-Universal" | Diddie Co., L. F., Marshfield, Wis. |
| | Dodd & Struthers, Des Moines, Ia. |
| | Dooley Lightning Rod Co., Topeka, Kans. |
| **"Silver Strand"** | **Electra Lightning Rod Co., Chicago, Ill.** |
| | Goetz, J., Hartford, Wis. |
| | Goshen Lightning Rod Co., Goshen, Ind. |
| | Hawkeye Lightning Rod Co., Cedar Rapids, Ia. |
| "Hollow Cable" | Hollow Cable Mfg. Co., Hornell, N. Y. |
| | Hum & Leatherman, Pittsburgh, Pa. |
| | Kress Co., G. R., Pittsburgh, Pa. |
| | Mast Lightning Rod Co., Dayton, O. |
| | Miller Lightning Rod Co., St. Louis, Mo. |
| | Moore Bros. Lightning Rod Co., Maryville, Mo. |
| | National-Standard Co., Niles, Mich. |
| | Nebraska Lightning Rod Co., Omaha, Neb. |
| | Owen, J. D. & E. G., Janesville, Wis. |
| **"R. H. Co.", Ajax** | **Reyburn, Hunter, Foy Co., Cincinnati, O.** |
| | St. Louis Lightning Rod Co., St. Louis, Mo. |
| | Security Lightning Rod Co., Burlington, Wis. |
| | Shinn Mfg. Co., W. C., Chicago, Ill. |
| | Shinn-Pool Cable Co., Oklahoma, Okla. |
| | Shrauger & Johnson, Atlantic, Ia. |
| | Swenson Grubber Co., Cresco, Ia. |
| | Thompson Lightning Rod Co., G. E., Owatonna, Minn. |
| | Thompson Mfg. Co., T., Brighton, Ia. |
| | Toledo Cable Co., Toledo, O. |
| | Townsley-Sewell Mfg. Co., Minneapolis, Minn. |
| | Washburne & Co., E. G., New York, N. Y. |

## MILKING MACHINES

| Trade Name | Name and Address of Manufacturer |
|---|---|
| "B-L-K" | Burrell & Co., D. H., Little Falls, N. Y. |
| "De Laval" | De Laval Separator Co., New York. |
| "Blue Ribbon" | Electric Milker Corp., Tower Bldg., Chicago, Ill. |
| "Empire" | Empire Cream Separator Co., Bloomfield, N. J. |
| | Groff & Son, F. A., Johnsville, N. Y. |
| "Hinman" | Hinman Milking Machine Co., Oneida, N. Y. |
| | Mehring, Wm. M., Keymar, Mich. |
| "Macartney" | Macartney-Somes Milking Machine Co., Bloomfield, N. J. |
| | Mullins Manufacturing Co., Brillion, Wis. |
| "Perfection" | Perfection Manufacturing Co., Minneapolis, Minn. |
| "Pine Tree" | Pine Tree Milking Machine Co., Chicago, Ill. |
| "Sharples Moto Milker" | Sharples Milker Co., West Chester, Pa. |
| "Victory" | Starch Brothers Co., La Crosse, Wis. |
| | Success Milking Machine Co., Milwaukee, Wis. |
| "Uebler" | Uebler Milking Machine Co., Inc., Vernon, N. Y. |
| "Universal" | Universal Milking Machine Co., Columbus, Ohio. |
| "Waterloo Boy" | Waterloo Gasoline Engine Co., Waterloo, Ia. |

## MOTORS

### D. C. Fractional-Horsepower Motors

| | |
|---|---|
| "Ace" | A-C Electrical Mfg. Co., Dayton, O. |
| | Adsit Laboratories, Minneapolis, Minn. |
| | Air-Way Electric Appliance Corp., Toledo, O. |
| | **Allis-Chalmers Mfg. Co., Milwaukee, Wis.** |
| | American Electric Cutting Machine Co., 149 Lafayette St., New York. |
| | Becker Electric Wks., Chicago, Ill. |
| | Bodine Electric Co., Chicago, Ill. |
| | Burke Electric Co., Erie, Pa. |
| | Central Armature Wks., Chicago, Ill. |
| | Chicago Surgical & Electrical Co., Chicago, Ill. |
| "Colonial" | Colonial Fan & Motor Co., Warren, O. |
| | Crocker-Wheeler Co., Ampere, N. J. |
| "Dayton" | Dayton Fan & Motor Co., Dayton, O. |
| | Diehl Mfg. Co., Elizabethport, N. J. |
| "Acme" | Dilg Mfg. & Trading Co., 27 E. 125th St., New York. |
| "Domestic" | Domestic Electric Co., Cleveland, O. |
| | East Jersey Pipe Co., Paterson, N. J. |
| "High-Grade" | Eck Dynamo & Motor Co., Belleville, N. J. |
| | Electro Dynamic Co., Bayonne, N. J. |
| | Emerson Electric Mfg. Co., St. Louis, Mo. |
| **"Fairbanks-Morse"** | **Fairbanks, Morse & Co., Chicago, Ill.** |
| | Fidelity Electric Co., Lancaster, Pa. |
| "G-E" | General Electric Co., Schenectady, N. Y. |
| "Polar Cub" | Gilbert Co., A. C., New Haven, Conn. |
| | Great Lakes Electric Mfg. Co., Chicago, Ill. |
| | Hamilton-Beach Mfg. Co., Racine, Wis. |
| | Holtzer-Cabot Electric Co., Boston, Mass. |
| | International X-Ray Corp., 326 Bway., New York. |
| | Janette Mfg. Co., Chicago, Ill. |
| | Jones-Motrola, Inc., 29 W. 35th St., New York. |
| "K. & D." | Kendrick & Davis Co., Lebanon, N. H. |
| "Kimble" | Kimble Electric Co., Chicago, Ill. |
| | Knapp Electric & Novelty Co., 511 W. 51st St., New York. |
| | Lancashire Dynamo & Motor Co. of Canada, Ltd., Toronto, Can. |
| | Liberty Electric Corp., Port Chester, N. Y. |
| | Louisville Electric Mfg. Co., Louisville, Ky. |
| "O. K." | Marathon Electric Mfg. Co., Wausau, Wis. |
| "Master" | Master Electric Co., Dayton, O. |
| | Munning & Co., A. P., Matawan, N. J. |
| | National Screw & Tack Co., Cleveland, O. |
| "Northwestern" | Northwestern Mfg. Co., Milwaukee, Wis. |
| | Ohio Electric & Controller Co., Cleveland, O. |
| | Olsen-Boettger Electric Mfg. Co., St. Paul, Minn. |
| | Osann Co., F., 245 7th Ave., New York. |
| **"Peerless"** | Peerless Electric Co., Warren, O. |
| | Persons Electric Co., Quincy, Ill. |

## MOTORS

### D. C. Fractional-Horsepower Motors (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| "Premier" | Premier Emergency Corp., 767 3rd Ave., New York. |
| | Racine Electric Co., Racine, Wis. |
| "R. & M." | Robbins & Myers Co., Springfield, O. |
| | Shedd Electric Co., Roselle Park, N. J. |
| | Sherman Mfg. Co., Battle Creek, Mich. |
| | Sprague Electric Wks. of General Electric Co., 527 W. 34th St., New York. |
| "Star" | Star Electric Motor Co., Newark, N. J. |
| | Sturtevant Co., B. F., Boston, Mass. |
| "Temco" | Temco Electric Motor Co., Leipsic, O. |
| "Menominee" | Tideman Electric Mfg. Co., Cairo, Ill. |
| | Wald Electric Mfg. Corp., Brooklyn, N. Y. |
| | **Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.** |
| "Dumore" | Wisconsin Electric Co., Racine, Wis. |

### A. C. Fractional-Horsepower Motors

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Adsit Laboratories, Minneapolis, Minn. |
| "Advance" | Advance Electric Co., St. Louis, Mo. |
| | Air-Way Electric Appliance Corp., Toledo, O. |
| | **Allis-Chalmers Mfg. Co., Milwaukee, Wis.** |
| "Twin-R" | American Radio & Research Corp., 21 Park Row, New York. |
| "Arnold" | Arnold Electric Co., Racine, Wis. |
| | Becker Electric Wks., Chicago, Ill. |
| | Bissell Co., F., Toledo, O. |
| | Bodine Electric Co., Chicago, Ill. |
| | Burke Electric Co., Erie, Pa. |
| | Bushnell Mfg. Co., Berkeley, Cal. |
| | Calumet Motor Co., Calumet, Mich. |
| "Century" | Century Electric Co., St. Louis, Mo. |
| | Chicago Surgical & Electrical Co., Chicago, Ill. |
| "Colonial" | Colonial Fan & Motor Co., Warren, O. |
| "Crawford" | Crawford Mfg. Co., 13 Park Row, New York. |
| | Crocker-Wheeler Co., Ampere, N. J. |
| "Dayton" | Dayton Fan & Motor Co., Dayton, O. |
| | Diehl Mfg. Co., Elizabethport, N. J. |
| "Domestic" | Domestic Electric Co., Cleveland, O. |
| "Edco" | Electro Dynamic Co., Bayonne, N. J. |
| | Emerson Electric Co., St. Louis, Mo. |
| **"Fairbanks-Morse"** | **Fairbanks, Morse Co., Chicago, Ill.** |
| | Fidelity Electric Co., Lancaster, Pa. |
| | General Electric Co., Schenectady, N. Y. |
| "Polar Cub" | Gilbert Co., A. C., New Haven, Conn. |
| "Gillespie" | Gillespie-Eden Corp., 7 Dey St., New York. |
| | Globe Electric Co., Chicago, Ill. |
| | Great Lakes Electric Mfg. Co., Chicago, Ill. |
| | Hallberg, J. H., 25 W. 45th St., New York. |
| | Hamilton-Beach Mfg. Co., Racine, Wis. |
| "H-G" | H-G Mfg. Co., St. Louis, Mo. |
| | Holtzer-Cabot Electric Co., Boston, Mass. |
| | International X-Ray Corp., 326 Bway., New York. |
| | Invincible Vacuum Cleaner Mfg. Co., Dover, O. |
| | Janette Mfg. Co., Chicago, Ill. |
| | Jones-Motrola, Inc., 29 W. 35th St., New York. |
| "K. & D." | Kendrick & Davis Co., Lebanon, N. H. |
| "K. & C." | Kilbourne & Clark Mfg. Co., Seattle, Wash. |
| "Kimble" | Kimble Electric Co., Chicago, Ill. |
| | Knapp Electric & Novelty Co., 511 W. 51st St., New York. |
| | Lancashire Dynamo & Motor Co. of Canada, Ltd., Toronto, Can. |
| | Liberty Electric Co., Port Chester, N. Y. |
| | Lincoln Electric Co., Cleveland, O. |
| | Louisville Electric Mfg. Co., Inc., Louisville, Ky. |
| "O. K." | Marathon Electric Mfg. Co., Wausau, Wis. |
| "Master" | Master Electric Co., Dayton, O. |
| | Ohio Electric & Controller Co., Cleveland, O. |
| | Peerless Electric Co., Warren, O. |
| | Persons Electric Co., Quincy, Ill. |
| "Johnson" | Phonograph Motors Corp., Chicago, Ill. |
| "Premier" | Premier Emergency Corp., 767 3rd Ave., New York. |
| | Racine Electric Co., Racine, Wis. |
| "Ohmer" | Recording & Computing Machines Co., Dayton, O. |

## MOTORS

### A. C. Fractional-Horsepower Motors (Continued)

"Reco" ....................Reynolds Electric Co., Chicago, Ill.
"R. & M." ....................Robbins & Myers Co., Springfield, O.
....................Shedd Electric Co., Roselle Park, N. J.
....................Sherman Mfg. Co., H. B., Battle Creek, Mich.
"Sieco" ....................Sieffert Electric Co., Evansville, Ind.
....................Sprague Electric Wks. of General Electric Co., 527 W. 34th St., New York.
....................Sunlight Electrical Mfg. Co., Warren, Ohio.
"Temco" ....................Temco Electric Motor Co., Leipsic, Ohio.
....................Thomson Co., Ltd., Montreal, Can.
"Menominee" ....................Tideman Electric Mfg. Co., Cairo, Ill.
"St. Louis" ....................Valley Electric Co., St. Louis, Mo.
....................Wagner Electric Co., St. Louis, Mo.
"Kazoo" ....................Warner Electric Co., Kalamazoo, Mich.
....................**Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.**
"Dumore" ....................Wisconsin Electric Co., Racine, Wis.
"Wodack" ....................Wodack Electrical Tool Co., Chicago, Ill.

### Universal A. C. and D. C. Motors

"Ace" ....................A-C Electrical Mfg. Co., Dayton, Ohio.
....................Adsit Laboratories, Minneapolis, Minn.
"Marvel" ....................American Thermostat Co., Newark, N. J.
....................Becker Electric Wks., Chicago, Ill.
"Be-Co" ....................Birtman Electric Co., Chicago, Ill.
....................Bodine Electric Co., Chicago, Ill.
....................Burke Electric Co., Erie, Pa.
"Domestic" ....................Domestic Electric Co., Cleveland, Ohio.
....................Electric Blower Co., Boston, Mass.
....................Emerson Electric Mfg. Co., St. Louis, Mo.
....................Fidelity Electric Co., Lancaster, Pa.
....................General Electric Co., Schenectady, N. Y.
"Polar Cub" ....................Gilbert Co., A. C., New Haven, Conn.
....................Green Electric Co., 81 Nassau St., New York.
....................Hallberg, J. H., 25 W. 45th St., New York.
....................Hamilton-Beach Mfg. Co., Racine, Wis.
....................International X-Ray Corp., 326 Bway., New York.
....................Knapp Electric & Novelty Co., 511 W. 51st St., New York.
....................Louisville Electric Mfg. Co., Inc., Louisville, Ky.
"White Cross" ....................National Stamping & Electric Wks., Chicago, Ill.
"Peerless" ....................Peerless Electric Co., Warren, Ohio.
"Johnson" ....................Phonograph Motors Corp., Chicago, Ill.
"Racine" ....................Racine Universal Motor Co., Chicago, Ill.
"R. & M." ....................Robbins & Myers Co., Springfield, Ohio.
....................Shedd Electric Co., Inc., Roselle Park, N. J.
....................Sturtevant Co., B. F., Boston, Mass.
"Menominee" ....................Tideman Electric Mfg. Co., Cairo, Ill.
....................**Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.**
"Superior" ....................Willey-Wray Electric Co., Cincinnati, Ohio.
"Dumore" ....................Wisconsin Electric Co., Racine, Wis.
"Wodack" ....................Wodack Electric Tool Co., Chicago, Illl.

## MOTOR CONTROLLERS

....................Allen-Bradley Company, Milwaukee, Wis.
....................Automatic Switch Company, New York, N. Y.
....................Cutler-Hammer Manufacturing Co., Milwaukee, Wis.
....................Electric Controller & Mfg. Co., Cleveland, Ohio.
....................General Electric Company, Schenectady, N. Y.
....................Industrial Controller Company, Milwaukee, Wis.
....................Knoeller Electric Company, De Pere, Wis.
....................Monitor Controller Company, Baltimore, Md.
....................National Electric Controller Company, Chicago, Ill.
....................Palmer Electric & Manufacturing Co., Cambridge, Mass.
....................Pennsylvania Electric Machine Co., Des Moines, Iowa.
....................Rowan Controller Company, Baltimore, Md.
....................Spero Electric Manufacturing Co., Cleveland, Ohio.
....................Sundh Electric Company, Newark, N. J.
....................Union Electric Manufacturing Co., Milwaukee, Wis.
....................Wagner Electric Manufacturing Co., St. Louis, Mo.
....................Ward Leonard Electric Company, Mt. Vernon, N. Y.
....................**Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.**

## MOVING PICTURE MACHINES

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Acme Motion Picture Projector Co., Chicago, Ill. |
| | American Pictograph Mfg. Co., Boston, Mass. |
| | American Projecting Co., Chicago, Ill. |
| | American Standard Motion Picture Co., New York, N. Y. |
| | Atlas Education Film Co., Chicago, Ill. |
| | Baird Motion Picture Machine Co., Newark, N. J. |
| | Cinematic Service Corp., Chicago, Ill. |
| | Cosmograph Motion Picture Machine Co., Morehead, Ky. |
| "DeVry"* | DeVry Corp., Chicago, Ill. |
| "Motiograph" | Enterprise Optical Mfg. Co., Chicago, Ill. |
| "Phantoscope" | Graphoscope Mfg. Co., Newark, N. J. |
| "Moviegraph" | Keystone Mfg. Co., Boston, Mass. |
| | Master Machines Corp., New York, N. Y. |
| "Triumph" | McIntosh Stereopticon Co., Chicago, Ill. |
| "Cinematograph," "Demograph," "Premier" | Pathescope Company of America, New York, N. Y. |
| "Simplex" | Precision Machine Co., New York, N. Y. |
| "Precision" | Simplex Photo Products Co., Richmond Hill, N. Y. |

*Portable type largely used by County Agents.

## RECEPTACLES AND SOCKETS

| | |
|---|---|
| "Leviton" | American Brass & Copper Co., New York, N. Y. |
| | Apex Electric Specialty Co., St. Louis, Mo. |
| "Benco" | Benjamin Electric Mfg Co., Chicago, Ill. |
| | Best Electric Corp., New York, N. Y. |
| "Dubli-Duty," "K. W.," "New Wrinkle," "Thomas," "Perkins," "Q. T.," "Wrinklet" | Bryant Electric Company, Bridgeport, Conn. |
| | Connecticut Electric Mfg. Co., Bridgeport, Conn. |
| "C. H." | Cutler-Hammer Mfg. Co., Milwaukee, Wis. |
| | Eagle Electric Mfg. Co., Brooklyn, N. Y. |
| "Circle F," "Norden" | Freeman Electric Co., Trenton, N. J. |
| | General Electric Co., Schenectady, N. Y. |
| "Presturn," "Quick Catch" | Hubbell, Inc., Harvey, Bridgeport, Conn. |
| | Johns-Manville, Inc., New York, N. Y. |
| "Levolier" | McGill Mfg. Co., Valparaiso, Ind. |
| | Majestic Electric Mfg. Co., St. Louis, Mo. |
| "Universal" | Metropolitan Electric Mfg. Co., Long Island City, N. Y. |
| | Morse, F. W., Boston, Mass. |
| | Ostrander & Co., W. R., New York. |
| | Paragon Electrical Mfg. Co., Akron, Ohio. |
| "Acme" | Parker & Son, J. H., Parkersburg, W. Va. |
| "Flute," "Flutoler," "Goliath," "Passmour" | Pass & Seymour, Solvay, N. Y. |
| | Paulding, J. I., New Bedford, Mass. |
| | Philadelphia Electrical & Mfg. Co., Philadelphia, Pa. |
| | Siemon Hard Rubber Corp., Bridgeport, Conn. |
| "Newcode" | Stanley & Patterson, New York, N. Y. |
| "Tecco" | Trenton Electric & Conduit Co., Trenton, N. J. |
| | Union Electric Company, Trenton, N. J. |
| | Walsh Electrical Supply Co., New York, N. Y. |
| "Universal" | Weber Electric Company, Boston, Mass. |
| | Wedmore Company, W. A., Camden, N. J. |
| | Yost Electric Manufacturing Co.. Toledo, O. |

## RHEOSTATS

| | |
|---|---|
| "Acme" | Acme Electric & Mfg. Co., Cleveland, Ohio. |
| | Allen-Bradley Co., Milwaukee, Wis. |
| | Automatic Electrical Devices Co., Cincinnati, Ohio. |
| | Automatic Transportation Co., Buffalo, N. Y. |
| "G. B. C." | Battery Appliance Corp., 3 E. 44th St., New York. |
| "C-H" | Cutler-Hammer Mfg. Co., Milwaukee, Wis. |
| "Wotton" | Electric Products Co., Cleveland, Ohio. |
| "F. B." | F. B. Electric & Mfg. Co., Detroit, Mich. |
| "F-F" | France Mfg. Co., Cleveland, Ohio. |
| | Great Lakes Radio Supplies Co., Inc., Elmhurst, Ill. |
| "HB" | Hobart Bros. Co., Troy, Ohio. |
| | Leonard Electric Mfg. Co., Cleveland, Ohio. |
| "National" | National Electric Controller Co., Chicago, Ill. |

## RHEOSTATS (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Prest-O-Lite Co., Indianapolis, Ind. |
| "Ross" | Ross Engineering Co., Detroit, Mich. |
| | Schaefer Bros. Co., Chicago, Ill. |
| "Standard-Baltimore" | Standard Electric Machinery Co., Baltimore, Md. |
| | Sundh Electric Co., Newark, N. J. |
| "Uemco" | Union Electric Mfg. Co., Milwaukee, Wis. |
| "Ribohm" | Ward Leonard Electric Co., Mt. Vernon, N. Y. |
| | **Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.** |

## SIGNS, ELECTRIC

| | |
|---|---|
| | A. K. S. Co., Chicago, Ill.. |
| | Adsing Co., Inc., New York, N. Y. |
| "Walzer" | A. & W. Electric Sign Co., Cleveland, O. |
| | American Sign Co., Kalamazoo, Mich. |
| "Opalite" | Bailey Reflector & Sign Co., Pittsburgh, Pa. |
| | Beacon Mfg. & Sales Co., New York, N. Y. |
| "Mason Monograms" | Betts & Betts Corp., New York, N. Y. |
| | Brilliant Sign Co., St. Louis, Mo. |
| | **Campbell Electric Co., Lynn, Mass.** |
| "Reflex" | Century Mfg. Co., Elizabethtown, Pa. |
| "Day-N-ite" | Chicago Electric Sign Co., Chicago, Ill. |
| | Clinton Sign Lens Co., Clinton, Ia. |
| | Cusack Co., T., Chicago, Ill. |
| | Dawes Electric Sign & Mfg. Co., Pittsburgh, Pa. |
| "Alpha-Bet," "Motograph" | Federal Electric Co., Chicago, Ill. |
| | Flashtric Sign Works, Chicago, Ill. |
| "Oplex-Sign" | Flexlume Sign Co., Buffalo, N. Y. |
| "Polaralite" | Frink, I. P., New York, N. Y. |
| | Grazier Electric Sign Products Co., Johnstown, Pa. |
| "Individuality" | Greenwood Advertising Co., Knoxville, Tenn. |
| "Luna," "Simplex" | Haller Consolidated Co., Chicago, Ill. |
| | Hi-Glo Sign Co., Wheeling, W. Va., |
| "Hemofam" | Hoggson Co., S. H., New York, N. Y. |
| | Indestructible Sign Co., Columbus, O. |
| | Maxwell Co., R. C., Trenton, N. J. |
| "Gritt" | National Retailers Advertising Corp., Indianapolis, Ind. |
| "Flash-I-Do" | National Stamping & Electric Wks., Chicago, Ill. |
| | Norden Electric Sign Co., New York, N. Y. |
| "Novelite," "Nulite," "Shedlight" | Novelty Electric Sign Co., San Francisco, Cal. |
| "Skedoodle" | Phelps Mfg. Co., Detroit, Mich. |
| "Raco" | Raymond, P. C., Buffalo, N. Y. |
| "Reco" | Reynolds Electric Co., Chicago, Ill. |
| "Resco" | Root Electric Sign Co., Lockport, N. Y. |
| "Phoenix" | Ryan Co., M. C., Phoenix, N. Y. |
| "Travelite" | Smith-Hecht Sign Co., Indianapolis, Ind. |
| | Snowite Sign Wks., Chicago, Ill. |
| "Canteen" | Solar Electric Co., Chicago, Ill. |
| | Strauss & Co., New York, N. Y. |
| | Tecla Electrical Laboratory, Detroit, Mich. |
| "Electrograph" | U. S. Electrograph Sign Corp., New York, N. Y. |
| "Travel-Light" | U. S. Parlagraph Co., Cleveland, O. |
| | Viking Sign Co., New York, N. Y. |
| "Disk," "Reflectric" | Western Display Co., St. Paul, Minn. |
| | **Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.** |
| | Young Electric Sign Mfg. Co., Bellevue, Ia. |

## STILLS, WATER

| | |
|---|---|
| "Barnstead" | Barnestead Still & Sterlizer Co., Boston, Mass. |
| "Wampus Kat" | Boulton-Perrigo Manufacturing Co., Oklahoma City, Okla. |
| | Cleveland Water Still Company, Cleveland, Ohio. |
| "Genco" | General Scientific Equipment Co., Philadelphia, Pa. |
| | Kline, Maurice, Philadelphia, Pa. |
| "Rochlitz" | Lalor Company, W. M., Chicago, Ill. |
| | Latimer Manufacturing Co., Ludington, Mich. |
| "Eureka" | Lattner Manufacturing Co., Cedar Rapids, Iowa. |

## STILLS, WATER (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Link Company, A. P., Brooklyn, N. Y. |
| | Precision Steam Meter Company, Chicago, Ill. |
| | Reliable Manufacturing Co., Cleveland, Ohio. |
| | Sargent Steam Meter Company, Chicago, Ill. |
| "Tripure" | Standard Water Systems Co., Hampden, N. J. |
| | Stokes Machine Company, Philadelphia, Pa. |
| | Vayo & Company, Chicago, Ill. |

## SWITCHES

### Battery Knife Switches

| | |
|---|---|
| | Ajax Electric Co., Jersey City, N. J. |
| "Bryant" | Bryant Electric Co., Bridgeport, Conn. |
| "Bunnell" | Bunnell & Co., J. H., 32 Park Place, New York. |
| | Canadian Coil Co., Ltd., Walkerville, Can. |
| | Cleveland Switchboard Co., Cleveland, Ohio. |
| | Detroit Coil Co., Detroit, Mich. |
| | Devoe Electric Switch Co., Montreal, Can. |
| | Edwards & Co., Inc., 140th & Exterior Sts., New York. |
| "Teteo" | Electric Tachometer Corp., Philadelphia, Pa. |
| | Electrical Mfg. Co., Cleveland, Ohio. |
| | Fahnestock Electric Co., Long Island City, N. Y. |
| "H & H" | Hart & Hegeman Mfg. Co., Hartford, Conn. |
| | Harvard Electric Co., Chicago, Ill. |
| | Laganke Electrical Co., Cleveland, Ohio. |
| "Leonard" | Leonard Electric Mfg. Co., Cleveland, Ohio. |
| | Majestic Electric Mfg. Co., St. Louis, Mo. |
| | Metropolitan Electric Mfg. Co., Long Island City, N. Y. |
| | Morse, F. W., Boston, Mass. |
| "Bulldog" | Mutual Electric & Machine Co., Detroit, Mich. |
| | Parkin Mfg. Co., San Rafael, Cal. |
| "Penn" | Penn Electrical & Mfg. Co., Irwin, Pa. |
| | Thordarson Electric Mfg. Co., Chicago, Ill. |
| "Circle T" | Trumbull Electric Mfg. Co., Plainville, Conn. |
| | United Electric Apparatus Co., Boston, Mass. |
| | **Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.** |
| | Windman-Goldsmith, Inc., Perth Amboy, N. J. |

### Fixture Switches

| | |
|---|---|
| "Arrow" | Arrow Electric Co., Hartford, Conn. |
| "Noscru" | Beaver Machine & Tool Co., Newark, N. J. |
| "Bryant" | Bryant Electric Co., Bridgeport, Conn. |
| "Pullite" | Canadian Duplexalite Co., Ltd., Montreal, Can. |
| "C-H" | Cutler-Hammer Mfg. Co., Milwaukee, Wis. |
| | Luminous Unit Co. Division of St. Louis Brass Mfg. Co., St. Louis, Mo. |
| "P. & S." | Pass & Seymour, Inc., Syracuse, N. Y. |
| | Sears, H. D., Boston, Mass. |

### Gas Engine (Angle Knife) Blade Switches

| | |
|---|---|
| | Ajax Electric Co., Jersey City, N. J. |
| "Bryant" | Bryant Electric Co., Bridgeport, Conn. |
| | Cleveland Switchboard Co., Cleveland, Ohio. |
| "Cemco" | Connecticut Electric Mfg. Co., Bridgeport, Conn. |
| | Pringle Electrical Mfg. Co., Philadelphia, Pa. |
| "Quick Action" | Quick Action Ignition Co., South Bend, Ind. |
| | Trumbull Electric Mfg. Co., Plainville, Conn. |
| | Windman-Goldsmith, Inc., Perth Amboy, N. J. |

### Panel Board (Combination Cut-out) Switches

| | |
|---|---|
| | Ajax Electric Co., Jersey City, N. J. |
| "Arrow" | Arrow Electric Co., Hartford, Conn. |
| | Benjamin Electric Co., Chicago, Ill. |
| "Bryant" | Bryant Electric Co., Bridgeport, Conn. |
| "Cemco" | Connecticut Electric Mfg. Co., Bridgeport, Conn. |
| "Condulet" | Crouse-Hinds Co., Syracuse, N. Y. |
| | Danbury Electric Mfg. Co., Danbury, Conn. |
| | Devoe Electric Switch Co., Montreal, Can. |
| | Electric Motor & Eng. Co., Canton, Ohio. |
| "Kwikon" | Fralick & Co., Chicago, Ill. |
| | General Electric Co., Schenectady, N. Y. |
| "H & H" | Hart & Hegeman Mfg. Co., Hartford, Conn. |

## SWITCHES

### Panel Board (Combination Cut-out) Switches (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| "Diamond H" | Hart Mfg. Co., Hartford, Conn. |
| | Laganke Electrical Co., Cleveland, Ohio. |
| | Large-Dail Mfg. Co., Inc., Philadelphia, Pa. |
| "Leonard" | Leonard Electric Mfg. Co., Cleveland, Ohio. |
| | Liberty Electric Corp., Port Chester, N. Y. |
| | Mendell Mfg. Co., Mattapoisett, Mass. |
| | Mesa Co., F. C., Irvington, N. J. |
| | Metropolitan Electric Mfg. Co, Long Island City, N. Y. |
| | Peterson Co., Inc., Chicago, Ill. |
| | Pringle Electrical Mfg. Co., Philadelphia, Pa. |
| "Square D" | Square D Co., Detroit, Mich. |
| | Takamine Commercial Corp., 120 Bway., New York. |
| "Tecco" | Trenton Electric & Conduit Co., Trenton, N. J. |
| "Circle T" | Trumbull Electric Mfg. Co., Plainville, Conn. |
| | Trumbull-Vanderpoel Electric Mfg. Co., Bantam, Conn. |
| | **Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.** |
| | Windman-Goldsmith, Inc., Perth Amboy, N. J. |

### Snap Switches

| Trade Name | Name and Address of Manufacturer |
|---|---|
| "Arrow" | Arrow Electric Co., Hartford, Conn. |
| | Beaver Machine & Tool Co., 50 Church St., New York. |
| "Perkins," "Yankee" | Bryant Electric Co., Bridgeport, Conn. |
| "Chic," "Keystone" | Chelten Electric Co., Philadelphia, Pa. |
| | Connecticut Electric Mfg. Co., Bridgeport, Conn. |
| | Cutler-Hammer Mfg. Co., Milwaukee, Wis. |
| "Echo," "Lungen" | Edwards & Co., 140th & Exterior Sts., New York. |
| | General Electric Co., Schenectady, N. Y. |
| | Gordon Electric Mfg. Co., Waterville, Conn. |
| "Diamond H," "Hartford" | Hart Mfg. Co., Hartford, Conn. |
| "H & H," "Hart" | Hart & Hegeman Mfg. Co., Hartford, Conn. |
| | Ideal Electric Mfg. Co., Philadelphia, Pa. |
| "Victor" | Keil & Son, F., New York. |
| | Machen Electric Mfg. Co, Philadelphia, Pa. |
| "Mesco" | Manhattan Electrical Supply Co., 17 Park Place, New York. |
| | Metropolitan Electric Mfg. Co., Long Island City, N. Y. |
| | New Haven Switch Co., New Haven, Conn. |
| | Pass & Seymour, Solvay, N. Y. |
| "New England" | Paulding, J. I., New Bedford, Mass. |
| "In-B-Tween" | Peerless Light Co., Chicago, Ill. |
| "National" | Standard Electric Mfg. Co., Chicago, Ill. |
| "Circle T" | Trumbull Electric Mfg. Co., Plainville, Conn. |
| | Trumbull-Vanderpoel Electric Mfg. Co., Bantam, Conn. |
| | Union Electric Co., Trenton, N. J. |
| | Universal Machine & Tool Corp., Chicago, Ill. |
| | Weber Electric Co., Boston, Mass. |

## SWITCH BOARDS

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | A-C Electrical Mfg. Co., Dayton, Ohio. |
| "FA" | Adam Electric Co., F., St. Louis, Mo. |
| | Ajax Electric Co., Jersey City, N. J. |
| | Allen-Bradley Co., Milwaukee, Wis. |
| | **Allis-Chalmers Mfg. Co., Milwaukee, Wis.** |
| | Barber Electric Mfg. Co., N. Attleboro, Mass. |
| | Barkelew Electric Mfg. Co., Middletown, Ohio. |
| | Boustead Electric & Mfg. Co., Minneapolis, Minn. |
| | Brown & Pengilly, Los Angeles, Cal. |
| "Perkins" | Bryant Electric Co., Bridgeport, Conn. |
| | Chicago Switchboard Mfg. Co., Chicago, Ill. |
| | Clay Electric Co., Philadelphia, Pa. |
| | Cleveland Switchboard Co., Cleveland, Ohio. |
| | Connecticut Dynamo & Motor Co., Irvington, N. J. |
| | Cregier Electrical Mfg. Co., Chicago, Ill. |
| | Devoe Electric Switch Co., Montreal, Can. |
| "Demco" | Drendell Electrical & Mfg. Co., San Francisco, Cal. |
| | Eaton Electrical Mfg. Co., Chicago, Ill. |
| | Electric Apparatus Co., Chicago, Ill. |
| | Electric Motor & Eng. Co., Canton, Ohio. |
| | Electric Panelboard Co., Rochester, N. Y. |

## SWITCH BOARDS (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Electric Power Equipment Corp., Philadelphia, Pa. |
| | Electromechanical Co., Baltimore, Md. |
| | Empire Eng. & Supply Co., 1 Dominick St., New York. |
| | General Electric Co., Schenectady, N. Y. |
| "Globe" | Globe Electric Co., Milwaukee, Wis. |
| | Hatfield Electric Co., Indianapolis, Ind. |
| | Hub Electric Co., Chicago, Ill. |
| | Kellogg Switchboard & Supply Co., Chicago, Ill. |
| | Kuhlman Eng. Co., Toledo, Ohio. |
| | Kurz & Root, Appleton, Wis. |
| | Laganke Electrical Co., Cleveland, Ohio. |
| | Large-Dail Mfg. Co., Inc., Philadelphia, Pa. |
| | Liberty Electric Corp., Port Chester, N. Y. |
| | Liberty Mfg. Co., Inc., New Orleans, La. |
| | Main Electric Co., Cleveland, Ohio. |
| | Marquette Electric Eng. Co., Chicago, Ill. |
| | Mendell Mfg. Co., Mattapoisett, Mass. |
| | Metropolitan Electric Co., S. Seattle, Wash. |
| | Metropolitan Electric Mfg. Co., Long Island City, N. Y. |
| | Miller & Pardee, Inc., Chicago, Ill. |
| | Monarch Electric Co., Ltd., St. Lambert, Can. |
| "Bull Dog" | Mutual Electric & Machine Co., Detroit, Mich. |
| "National" | National Electric Co., Charleston, W. Va. |
| | NePage-McKenny Co., Seattle, Wash. |
| "Newgard" | Newgard & Co., H., Chicago, Ill. |
| | Nyelec Switchboard Co., 422 E. 53rd St., New York. |
| "Penn" | Penn Electrical & Mfg. Co., Irwin, Pa. |
| | Perfection Storage Battery Co., Chicago, Ill. |
| | Peterson Co., Inc., Chicago, Ill. |
| | Pittsburgh Electrical & Machine Wks., Pittsburgh, Pa. |
| | Post-Glover Electric Co., Cincinnati, Ohio. |
| | Pringle Electrical Mfg. Co., Philadelphia, Pa. |
| | Robertson Electric Construction Co., Buffalo, N. Y. |
| "Safety Products" | Safety Electric Products Co., Inc., Los Angeles, Cal. |
| | Schmidt Electric Co., A. R., Milwaukee, Wis. |
| | Southern Electrical Equipment Co., Charlotte, N. C. |
| | Sprague Electric Wks. of General Electric Co., 527 W. 90th St., New York. |
| "Standard-Baltimore" | Standard Electric Machinery Co., Baltimore, Md. |
| | Standard Electrical Construction Co., San Francisco, Cal. |
| "Standard" | Standard Mechanical Equipment Co., Dallas, Tex. |
| | Sterling Switchboard Co., Camden, N. J. |
| | Sundh Electric Co., Newark, N. J. |
| | Superior Engineering Co., Pittsburgh, Pa. |
| | Swartz Electric Co., Indianapolis, Ind. |
| | Tanner & Co., W. F., Baltimore, Md. |
| | Thomson Co., Ltd., Montreal, Can. |
| "Circle T" | Trumbull Electric Mfg. Co., Plainville, Conn. |
| | Western Electric Wks., Portland, Ore. |
| | Western Safety Mfg. Co., San Francisco, Cal. |
| **"Burke"** | **Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.** |
| | Wisconsin Electrical & Mfg. Co., Milwaukee, Wis. |
| | Worcester Electric Mfg. Co., Worcester, Mass. |
| | Wurdack Electric Mfg. Co., St. Louis, Mo. |

## TANK ALARMS

| | |
|---|---|
| | Electrical Repair Co., New York, N. Y. |
| "Shamrock" | Leahy, John J., New York, N. Y. |
| "Neu" | Ostrander & Company, New York, N. Y. |
| | Patrick & Wilkins Company, New York, N. Y. |
| "Patterson" | Stanley & Patterson, New York, N. Y. |
| | Stern, Louis, Philadelphia, Pa. |

## TELEPHONES, INTERCOMMUNICATING

| | |
|---|---|
| | American Electric Co., Chicago, Ill. |
| "Thermophone" | American Thermophone Co., Boston, Mass. |
| | American Watchman's Clock Co., 150 Nassau St., New York. |
| | Auth Electrical Specialty Co., 422 E. 53rd St., New York. |
| "B. A. X." | Automatic Electric Co., Chicago, Ill. |

## TELEPHONES, INTERCOMMUNICATING (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| | Chicago Hand Phone Co., Chciago, Ill. |
| "Chicago" | Chicago Telephone Supply Co., Elkhart, Ind. |
| "Connecticut" | Connecticut Telephone & Electric Co., Meriden, Conn. |
| | Couch Co., Inc., S. H., Quincy, Mass. |
| "Dictograph" | Dictograph Products Corp., 220 W. 42nd St., New York. |
| "Federal" | Federal Telephone & Telegraph Co., Buffalo, N. Y. |
| | Globe Phone Mfg. Co., Reading, Mass. |
| | Hepburn Telephone Mfg. Co., Chicago, Ill. |
| | Holtzer-Cabot Electric Co., Boston, Mass. |
| | Kellogg Switchboard & Supply Co., Chicago, Ill. |
| | Klaxon Co., Newark, N. J. |
| | Leich Electric Co., Genoa, Ill. |
| "Crown" | Liddell Electric Mfg. Co., Bridgeport, Conn. |
| | Monarch Telephone Mfg. Co., Ft. Dodge, Ia. |
| | North Electric Mfg. Co., Galion, O. |
| | Ostrander & Co., W. R., 317 Bway., New York. |
| | Pettes & Randall Co., 152 Nassau St., New York. |
| | Samson Electric Co., Canton, Mass. |
| | Screw Machine Products Corp., Providence, R. I. |
| | Spielman Electric Co., 1931 Bway., New York. |
| "Intertalk" | Stanley & Patterson, 34 Hubert St., New York. |
| | Stoddard Telephone Construction Co., Monroe, Mich. |
| "Inter-Comm-Phone" | Stromberg-Carlson Telephone Mfg. Co., Rochester, N. Y. |
| | Telephone Shop, Chicago, Ill. |
| | **Western Electric Co., Inc., 195 Bway., New York.** |

## TIME SWITCHES

| | |
|---|---|
| | A. A. Mfg. Co., Brooklyn, N. Y. |
| | A & W Electric Sign Co., Cleveland, O. |
| "Con-Tac-Tor" | Absolute Con-Tac-Tor Co., Chicago, Ill. |
| | Adsit Laboratories, Minneapolis, Minn. |
| | Allen-Bradley Co., Milwaukee, Wis. |
| "Anderson" | Anderson Mfg. Co., Boston, Mass. |
| | Automatic Electric Mfg. Co., Mankato, Minn. |
| **"Campbell"** | **Campbell Electric Co., Lynn, Mass.** |
| "Venner" | Chamberlain & Hookham Meter Co., Toronto, Can. |
| "Dayton" | Dimler Machine Tool Co., Dayton, O. |
| | Devoe Electric Switch Co., Montreal, Can. |
| | General Electric Co., Schenectady, N. Y. |
| "Hartford" | Hartford Time Switch Co., 71 Murray St., New York. |
| **"Mercury"** | **Mercury Time Switch Co., Detroit, Mich.** |
| | Minerallac Electric Co., Chicago, Ill. |
| "Barnes" | Morris Co., Inc., J. O., 1270 Bway., New York. |
| | Palmer Electric & Mfg. Co., Cambridge, Mass. |
| "Paragon" | Paragon Electric Co., Chicago, Ill. |
| | Philips Time Switch Co., Shelton, Conn. |
| "Reliance" | Reliance Automatic Lighting Co., Racine, Wis. |
| | Sohm Electric Co., Chicago, Ill. |
| | Sterling Clock Co., Inc., 220 E. 42nd St., New York. |
| | Sundh Electric Co., Newark, N. J. |
| | Takamine Commercial Corp., 120 Bway., New York. |
| | Universal Time Switch Mfg. Co., Cleveland, O. |
| | **Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.** |

# WATER SYSTEMS (Electric)

## SHALLOW WELLS

Maximum Lift 20 to 25 Feet

| Trade Name | Type of Model | Pump Cap. Gals. per Hr. | Tank Capacity and Type | Motor | Floor Space Inches | Weight Inches | Weight Boxed Lbs. |
|---|---|---|---|---|---|---|---|
| **The Bishop & Babcock Co., Cleveland, Ohio** | | | | | | | |
| "Champion" | 4,979-A | 185 | Any | 1/4 | 13x27 | 30 | 160 |
| **The Crestline Mfg. Co., Crestline, Ohio** | | | | | | | |
| "Cremco" | C | .... | 42 gals. | 1/6 | 30x32x27 Tank 16x42 | 42 | 294 |
| "Cremco" | D | .... | 52 gals. | 1/6 | 30x32x27 Tank 16x60 | 60 | 324 |
| "Cremco" | E | .... | 100 gals. | 1/6 | 30x32x27 Tank 22x70 | 70 | 394 |
| **The Dayton Pump & Mfg. Co., Dayton, Ohio** | | | | | | | |
| "Dayton" | Unisystem | 100 | 30 gals. | 1/8 | .... | .. | 185 |
| "Dayton" | 140-A | 160 | 42 gals. | 1/8 | .... | .. | 260 |
| "Dayton" | 141 | 160 | 52 gals. | 1/8 | .... | .. | 270 |
| "Dayton" | 142 | 160 | 80 gals. | 1/8 | .... | .. | 270 |
| "Dayton" | 143 | 160 | 120 gals. | 1/8 | .... | .. | 320 |
| "Dayton" | 144 | 160 | 220 gals. | 1/8 | .... | .. | 470 |
| "Dayton" | 241 | 210 | 52 gals. | 1/6 | .... | .. | 330 |
| "Dayton" | 242 | 210 | 80 gals. | 1/6 | .... | .. | 330 |
| "Dayton" | 243 | 210 | 120 gals. | 1/6 | .... | .. | 400 |
| "Dayton" | 244 | 210 | 220 gals. | 1/6 | .... | .. | 540 |
| "Dayton" | 381 | 350 | 80 gals. | 1/4 | .... | .. | ... |
| "Dayton" | 382 | 350 | 120 gals. | 1/4 | .... | .. | ... |
| "Dayton" | 383 | 350 | 220 gals. | 1/4 | .... | .. | ... |
| "Dayton" | 384 | 350 | 315 gals. | 1/4 | .... | .. | ... |
| **W. & B. Douglas, Middletown, Conn.** | | | | | | | |
| "Pneutank" | 770-A | 225 | 100 gals. | 1/4 | 30x36 | 61 | 380 |
| "Perfecto" | 705 | 240-8,800 | Any | 1/3-7 1/2 | .... | .. | ... |
| **The Duro Pump & Mfg. Co., Dayton, Ohio** | | | | | | | |
| "Duro" | A-2,001 | 90 | 20-P | 1/8 | .... | 52 | 200 |
| "Duro" | B-2,001 | 90 | 80-P | 1/8 | .... | 64 | 255 |
| "Duro" | 200 | 180 | 42-220-P | 1/8 | .... | .. | ... |
| "Duro" | 300 | 360 | 42-315-P | 1/4 | .... | .. | ... |
| "Duro" | 2,100 | 600-700 | 42-525-P | 1/2 | .... | .. | ... |
| **Flint & Walling Mfg. Co., Kendallville, Ind.** | | | | | | | |
| "Hoosier" | 1,341 | 250 | Any | 1/4 | 12x22 | 28 | 118 |
| "Hoosier" | 1,326-1 | 510 | Any | 1/2 | .... | .. | 248 |
| "Hoosier" | 1,326-2 | 850 | Any | 3/4 | .... | .. | 400 |
| "Hoosier" | 1,326,-3 | 1,200 | Any | 1 | .... | .. | 525 |
| **Fort Wayne Eng. & Mfg. Co., Fort Wayne, Ind.** | | | | | | | |
| "Paul" | M-970 | 100 | 3E | 1/8 | 34x13 | 30 | 185 |
| "Paul" | M-950 | 180 | 5 1/2E | 1/6 | 38x14 | 32 | 275 |
| "Paul" | A-970 | 100 | 42E | 1/8 | 27x28 | 54 | 220 |
| "Paul" | A-950 | 180 | 52E | 1/6 | 26x32 | 54 | 340 |
| "Paul" | B-950 | 180 | 100E | 1/6 | 26x37 | 65 | 400 |
| "Paul" | GM-P 82 | 360 | 140E | 1/2 | 46x43 | 77 | 830 |
| "Paul" | GM-S 82 | 360 | 315E | 1/2 | 46x42 | 77 | 1,100 |
| "Paul" | GM-U 82 | 360 | 630E | 1/2 | .... | .. | 1,550 |
| "Paul" | GM-O 83 | 720 | 315E | 1 | .... | .. | 1,250 |
| "Paul" | GM-R 83 | 720 | 630E | 1 | .... | .. | 1,700 |
| "Paul" | GM-S 83 | 720 | 1,000E | 1 | .... | .. | 2,400 |
| "Paul" | GM-T 83 | 720 | 1,500E | 1 | .... | .. | 3,000 |
| "Paul" | GM-O 84 | 1,440 | 630E | 2 | .... | .. | 2,000 |
| "Paul" | GM-P 84 | 1,440 | 1,000E | 2 | .... | .. | 2,700 |
| "Paul" | GM-R 84 | 1,440 | 1,500E | 2 | .... | .. | 3,500 |
| "Paul" | GM-S 84 | 1,440 | 2,260E | 2 | .... | .. | 5,600 |

# SHALLOW WELLS (Continued)

| Trade Name | Type of Model | Pump Cap. Gals. per Hr. | Tank Capacity and Type | Motor | Floor Space Inches | Height Inches | Weight Boxed Lbs. |
|---|---|---|---|---|---|---|---|
| **The Goulds Mfg. Co., Seneca Falls, N. Y.** | | | | | | | |
| "Autowater" | Fig. X-1695 | 180 | 30 | ¼ | 36x19 | 40 | 265 |
| "Autowater" | Fig. W-1695 | 180 | No tank | ¼ | 33x12 | 17 | 150 |
| "Autowater" | Fig. V-1695 | 360 | No tank | ¼ | 33x13 | 20 | 160 |
| **The Humphreys Mfg. Co., Mansfield, Ohio** | | | | | | | |
| "Silent Pumper" | 550 | 180 | Any | ⅙-¼ | 11x28 | .. | 160 |
| "Silent Pumper" | 560 | 250 | Any | ¼-⅓ | 11x28 | .. | 180 |
| "Silent Pumper" | 555 | 320 | Any | ⅓-½ | 11x28 | .. | 180 |
| "Silent Pumper" | 5,500 | 180 | 42 Black | ⅙-¼ | 29x35 | .. | 330 |
| "Silent Pumper" | 5,501 | 180 | 42 Galv | ⅙-¼ | 29x35 | .. | 330 |
| "Silent Pumper" | 5,502 | 180 | 52 Black | ⅙-¼ | 29x35 | .. | 360 |
| "Silent Pumper" | 5,503 | 180 | 52 Galv | ⅙-¼ | 29x35 | .. | 360 |
| "Silent Pumper" | 5,504 | 180 | 80 Black | ⅙-¼ | 29x35 | .. | 390 |
| "Silent Pumper" | 5,505 | 180 | 80 Galv | ⅙-¼ | 29x35 | .. | 390 |
| "Silent Pumper" | 5,506 | 180 | 120 Black | ⅙-¼ | 48x60 | .. | 430 |
| "Silent Pumper" | 5,507 | 180 | 120 Galv | ⅙-¼ | 48x60 | .. | 430 |
| "Silent Pumper" | 5,508 | 180 | 215 Black | ⅙-¼ | 54x72 | .. | 635 |
| "Silent Pumper" | 5,510 | 180 | 315 Black | ⅙-¼ | 60x72 | .. | 735 |
| "Silent Pumper" | 5,512 | 180 | 530 Black | ⅙-¼ | 60x72 | .. | 210 |
| "Silent Pumper" | 5,600 | 250 | 42 Black | ¼-⅓ | 29x35 | .. | 350 |
| "Silent Pumper" | 5,601 | 250 | 42 Galv | ¼-⅓ | 29x35 | .. | 350 |
| "Silent Pumper" | 5,602 | 250 | 52 Black | ¼-⅓ | 29x35 | .. | 380 |
| "Silent Pumper" | 5,603 | 250 | 52 Galv | ¼-⅓ | 29x35 | .. | 380 |
| "Silent Pumper" | 5,604 | 250 | 80 Black | ¼-⅓ | 29x35 | .. | 410 |
| "Silent Pumper" | 5,605 | 250 | 80 Galv | ¼-⅓ | 29x35 | .. | 410 |
| "Silent Pumper" | 5,606 | 250 | 120 Black | ¼-⅓ | 48x60 | .. | 450 |
| "Silent Pumper" | 5,607 | 250 | 120 Galv | ¼-⅓ | 46x60 | .. | 450 |
| "Silent Pumper" | 5,608 | 250 | 215 Black | ¼-⅓ | 54x72 | .. | 655 |
| "Silent Pumper" | 5,610 | 250 | 315 Black | ¼-⅓ | 60x72 | .. | 755 |
| "Silent Pumper" | 5,612 | 250 | 530 Black | ¼-⅓ | 60x72 | .. | 1,230 |
| "Silent Pumper" | 5,554 | 320 | 80 Black | ⅓-½ | 29x35 | .. | 410 |
| "Silent Pumper" | 5,555 | 320 | 80 Galv | ⅓-½ | 29x35 | .. | 410 |
| "Silent Pumper" | 5,556 | 320 | 120 Black | ⅓-½ | 48x60 | .. | 450 |
| "Silent Pumper" | 5,557 | 320 | 120 Galv | ⅓-½ | 48x60 | .. | 450 |
| "Silent Pumper" | 5,558 | 320 | 215 Black | ⅓-½ | 54x72 | .. | 655 |
| "Silent Pumper" | 5,560 | 320 | 315 Black | ⅓-½ | 60x72 | .. | 755 |
| "Silent Pumper" | 5,562 | 320 | 530 Black | ⅓-½ | 60x72 | .. | 1,230 |

As an added precaution against stalling of the motor, due to a large drop in voltage of farm lighting units, a larger motor is furnished on all 32-volt systems at no extra charge.

| Trade Name | Type of Model | Pump Cap. Gals. per Hr. | Tank Capacity and Type | Motor | Floor Space Inches | Height Inches | Weight Boxed Lbs. |
|---|---|---|---|---|---|---|---|
| **Kewanee Private Utilities Co., Kewanee, Ill.** | | | | | | | |
| "Kewanee" | 1 | 115 | 140 | ⅙ | 15x20 | 22 | 150 |
| "Kewanee" | 8-A | 324 | 420 | ½ | 26x30 | 39 | 400 |
| "Kewanee" | 8-C | 600 | 525 | 1 | 26x30 | 39 | 450 |
| "Kewanee" | 35-A | 625 | 735 | 1 | 24x45 | 45 | 700 |
| "Kewanee" | 35-B | 1,000 | 1,000 | 2 | 24x45 | 45 | 750 |
| **Mast, Foos & Company, Springfield, Ohio** | | | | | | | |
| "Buckeye" | 1,003 | 180 | 42-120-P | ⅙ | .... | 50 | 350 |
| "Buckeye" | 2,103 | 500 | Any | ¾ | .... | .. | ... |
| "Buckeye" | 2,105 | 920 | Any | 1 | .... | .. | ... |
| "Buckeye" | 2,118 | 1,630 | Any | 1½ | .... | .. | ... |
| "Buckeye" | 2,134 | 2,750 | Any | 3 | .... | .. | ... |
| **The Monarch Engineering Co., Dayton, Ohio** | | | | | | | |
| "Monarch" | 100 | 100 | 35 B | ⅛ | .... | .. | 80 |
| "Monarch" | 101 | 100 | 35 Black | ⅛ | .... | .. | 215 |
| "Monarch" | 102 | 100 | 35 Galv | ⅛ | .... | .. | 215 |
| "Monarch" | 103 | 100 | 70 Black | ⅛ | .... | .. | 360 |
| "Monarch" | 104 | 100 | 70 Galv | ⅛ | .... | .. | 360 |
| "Monarch" | 105 | 100 | 120 Black | ⅛ | .... | .. | 500 |
| "Monarch" | 106 | 100 | 120 Galv | ⅛ | .... | .. | 500 |

# SHALLOW WELLS (Continued)

| Trade Name | Type of Model | Pump Cap. Gals. per Hr. | Tank Capacity and Type | Motor | Floor Space Inches | Height Inches | Weight Boxed Lbs. |
|---|---|---|---|---|---|---|---|
| **The Monarch Engineering Co., Dayton, Ohio (Continued)** | | | | | | | |
| "Monarch" | 107 | 100 | 220 Black | ⅛ | .... | .. | ... |
| "Monarch" | 108 | 100 | 220 Galv | ⅛ | .... | .. | ... |
| "Monarch" | 109 | 100 | 315 Black | ⅛ | .... | .. | ... |
| "Monarch" | 110 | 100 | 315 Galv | ⅛ | .... | .. | ... |
| "Monarch" | 201 | 200 | 35 Black | ⅙ | .... | .. | 220 |
| "Monarch" | 202 | 200 | 35 Galv | ⅙ | .... | .. | 220 |
| "Monarch" | 203 | 200 | 70 Black | ⅙ | .... | .. | 265 |
| "Monarch" | 204 | 200 | 70 Galv | ⅙ | .... | .. | 265 |
| "Monarch" | 205 | 200 | 120 Black | ⅙ | .... | .. | 475 |
| "Monarch" | 206 | 200 | 120 Galv | ⅙ | .... | .. | 475 |
| "Monarch" | 207 | 200 | 220 Black | ⅙ | .... | .. | ... |
| "Monarch" | 208 | 200 | 220 Galv | ⅙ | .... | .. | ... |
| "Monarch" | 209 | 200 | 315 Black | ⅙ | .... | .. | ... |
| "Monarch" | 210 | 200 | 315 Galv | ⅙ | .... | .. | ... |
| 'Monarch" | 401 | 400 | 35 Black | ¼ | .... | .. | 345 |
| "Monarch" | 402 | 400 | 35 Galv | ¼ | .... | .. | 345 |
| "Monarch" | 403 | 400 | 70 Black | ¼ | .... | .. | 305 |
| "Monarch" | 404 | 400 | 70 Galv | ¼ | .... | .. | 305 |
| "Monarch" | 405 | 400 | 120 Black | ¼ | .... | .. | 515 |
| "Monarch" | 406 | 400 | 120 Galv | ¼ | .... | .. | 515 |
| "Monarch" | 407 | 400 | 220 Black | ¼ | .... | .. | ... |
| "Monarch" | 408 | 400 | 220 Galv | ¼ | .... | .. | ... |
| "Monarch" | 409 | 400 | 315 Black | ¼ | .... | .. | ... |
| "Monarch" | 410 | 400 | 315 Galv | ¼ | .... | .. | ... |
| **Leader Trahern Products Co., Decatur & Rockford, Ill.** | | | | | | | |
| "Leader" | Fig. 11 | 150 | Any | ⅙ | 11½x45 | 24 | 170 |
| "Leader" | Fig. 7B | 210 | Any | ¼ | 11½x45 | 23 | 200 |
| "Leader" | Fig. 8, No. 36M. | 360 | Any | ⅓ | 16½x42 | 38 | 400 |
| "Leader" | Fig. 8, No. 48M. | 480 | Any | ½ | 16½x40 | 38 | 405 |
| "Leader" | Fig. 8, No. 54M. | 540 | Any | ¾ | 17½x42 | 39 | 430 |
| "Leader" | Fig. 8, No. 72M. | 720 | Any | 1 | 17½x60 | 34½ | 450 |
| "Leader" | Fig. 8, 5x5 | 2,000 | Any | 3 | 18 x60 | 34½ | 550 |
| **Rider-Ericsson Engine Co., New York, N. Y.** | | | | | | | |
| "Little Giant" | E C T-1 | 100 | 8 | ⅙ | .... | .. | 130 |
| "Little Giant" | E C T-1 | 200 | 8 | ⅙ | .... | .. | 130 |
| "Little Giant" | E C O | 100 | 52 | ⅙ | .... | .. | 300 |
| "Little Giant" | E C OO | 100 | 100 | ⅙ | .... | .. | 375 |
| "Little Giant" | E C-1 | 200 | 52 | ⅙ | .... | .. | 330 |
| "Little Giant" | E C 1-A | 200 | 100 | ⅙ | .... | .. | 400 |
| "Little Giant" | E C-2 | 300 | 52 | ¼ | .... | .. | 395 |
| "Little Giant" | E C 2-A | 300 | 100 | ¼ | .... | .. | 465 |
| "Little Giant" | 40-H-1 | 200 | Any | ⅙ | .... | .. | 175 |
| "Little Giant" | 40-H-2 | 300 | Any | ¼ | .... | .. | 185 |
| "Little Giant" | 40-H-4 | 300 | Any | ½ | .... | .. | 215 |
| "Little Giant" | 40-H-7 | 600 | Any | ½ | .... | .. | 275 |
| "Little Giant" | 40-H-8 | 600 | Any | ¾ | .... | .. | 315 |
| "Little Giant" | 40-H-9 | 900 | Any | ¾ | .... | .. | 335 |
| "Little Giant" | 40- I -1 | 200 | 52 | ⅙ | .... | .. | 325 |
| "Little Giant" | 40- I -1-A | 200 | 100 | ⅙ | .... | .. | 395 |
| "Little Giant" | 40- I -2 | 200 | 52 | ¼ | .... | .. | 350 |
| "Little Giant" | 40- I -2-A | 200 | 100 | ¼ | .... | .. | 420 |
| "Little Giant" | 40- I -4 | 300 | 52 | ½ | .... | .. | 415 |
| "Little Giant" | 40- I -4-A | 300 | 100 | ½ | .... | .. | 485 |
| **The George J. Roberts Co., Dayton, Ohio** | | | | | | | |
| "Gem" | 400 | 150 | 42 | ⅙ | 21x10 | 22 | 220 |
| "Gem" | 401 | 150 | 80 | ⅙ | 21x10 | 22 | 305 |
| "Gem" | 402 | 150 | 120 | ⅙ | 21x10 | 22 | 345 |
| "Gem" | 403 | 300 | 42 | ¼ | 21x10 | 29 | 295 |
| "Gem" | 404 | 300 | 80 | ¼ | 21x10 | 29 | 380 |

## SHALLOW WELLS (Continued)

| Trade Name | Type of Model | Pump Cap. Gals. per Hr. | Tank Capacity and Type | Motor | Floor Space Inches | Height Inches | Weight Boxed Lbs. |
|---|---|---|---|---|---|---|---|
| | | | **The George J. Roberts Co., Dayton, Ohio (Continued** | | | | |
| "Gem" | 405 | 300 | 120 | ¼ | 21x10 | 29 | 420 |
| "Gem" | 406 | 300 | 220 | ¼ | 21x10 | 29 | 700 |
| "Gem" | 407 | 400 | 42 | ⅓ | 21x12 | 30 | 345 |
| "Gem" | 408 | 400 | 80 | ⅓ | 21x12 | 30 | 440 |
| "Gem" | 409 | 400 | 120 | ⅓ | 21x12 | 30 | 470 |
| "Gem" | 410 | 400 | 220 | ⅓ | 21x12 | 30 | 750 |
| "Roberts"* | 11 | 1,200 | Any | 1½ | .... | .. | ... |
| "Roberts"* | 12 | 1,750 | Any | 2 | .... | .. | ... |
| "Roberts" | 13 | 2,600 | Any | 3-5 | .... | .. | ... |
| "Roberts" | 14 | 3,900 | Any | 5-7½ | .... | .. | ... |
| "Roberts" | 15 | 6,000 | Any | 7½-10 | .... | .. | ... |
| "Roberts" | 16 | 8,700 | Any | 10 | .... | .. | ... |
| | | | **Rumsey Pump Co., Seneca Falls, N. Y.** | | | | |
| "Rumsey"* | A-215 | 180 | 85 | ¼ | .... | .. | 351 |
| "Rumsey"* | A-216 | 285 | 117 | ½ | .... | .. | 675 |
| "Rumsey" | A-217 | 540 | 315 | ¾ | .... | .. | 1,305 |
| | | | **Twinvolute Pump & Mfg. Co., Inc., Newark, N. J.** | | | | |
| "Hart"* | 1 " S S | 1,200 | Any | 1½-1 | 30x12 | 12 | 240 |
| "Heir" | 1¼" S S | 2,100 | Any | 1 -2 | 32x12 | 13 | 270 |
| "Hire" | 1½" S S | 3,300 | Any | 2 -3 | 36x15 | 15 | 320 |
| "Holm" | 2 " S S | 5,500 | Any | 3 -5 | 36x15 | 18 | 360 |
| "Babe" | 1 " BE | 1,200 | Any | 1 -2 | 28x10 | 12 | 320 |
| "Bald" | 1¼" BE | 2,000 | Any | 2- 3 | 30x12 | 15 | 370 |
| "Hale" | 1½" A S | 3,600 | Any | 3 -5 | 36x14 | 16 | 620 |
| "Halo" | 2 " A S | 6,000 | Any | 5 -7½ | 40x16 | 18 | 700 |
| | | | **The Vail-Kimes Co., Dayton, Ohio** | | | | |
| Electric Rain Water Pumps. | | | | | | | |
| "V. & K." | Fig. 120-0 | 120 | 42 | ⅛ | 29x10 | 18 | 100 |
| "V. & K." | Fig. 120-1 | 180 | 53 | ⅙ | 33x10 | 20 | 120 |
| "V. & K." | Fig. 120-1 | 180 | 82 | ⅙ | 33x10 | 20 | ... |
| Complete Shallow Well Systems. | | | | | | | |
| "V. & K." | E2-267 | 120 | 42 | ⅛ | 23x28 | 48 | 240 |
| "V. & K." | E3-267 | 180 | 53 | ⅙ | 25x30 | 50 | 300 |
| "V. & K." | E4-267 | 120 | 82 | ⅛ | 23x32 | 63 | 300 |
| "V. & K." | F4-267 | 210 | 82 | ¼ | 32x32 | 63 | 370 |
| "V. & K." | F6-267 | 210 | 120 | ¼ | 32x36 | 63 | 430 |
| "V. & K."* | F8-267 | 210 | 220 | ¼ | 32x40 | 75 | 480 |
| "V. & K."* | G8-267 | 360 | 220 | ⅓ | 36x44 | 75 | 520 |
| | | | **The Western Pump Co., Davenport, Iowa** | | | | |
| "Westco" | No. 40 | 350 | No Tank | ¼ | 20x15 | 13 | 155 |
| "Westco" | No. 41 | 350 | No Tank | ¼ | 20x15 | 13 | 170 |
| "Westco" | No. 45 | 500 | No Tank | ½ | 24x23 | 13 | 190 |
| "Westco" | No. 50 | 900 | No Tank | 1 | 24x32 | 23 | 325 |

* Also Pneumatic Tank Systems and Automatic Drain Pumps.

# WATER SYSTEMS (Electric)

## DEEP WELLS

| Trade Name | Type of Model | Smallest Size of Well for Cap. Given Inches | Capacity Gallons Per Hour | Depth to Water Ft. | Motor H. P. | Tank Capacity | Floor Space Inches | Height Inches | Weight Boxed Lbs. |
|---|---|---|---|---|---|---|---|---|---|
| **Chandler Pump Co., Cedar Rapids, Iowa** | | | | | | | | | |
| "Hawkeye" | 104-A-1 | ... | 100 | ... | ¼ | ... | 18x16 | 53 | ... |
| "Hawkeye" | 104-A-2 | ... | 140 | ... | ¼ | ... | 18x16 | 53 | ... |
| "Hawkeye" | 104-A-3 | ... | 180 | ... | ¼ | ... | 18x16 | 53 | ... |
| "Hawkeye" | 104-FP-1 | ... | 100 | ... | ¼ | ... | 18x16 | 53 | ... |
| "Hawkeye" | 104-FP-2 | ... | 140 | ... | ¼ | ... | 18x16 | 53 | ... |
| "Hawkeye" | 104-FP-3 | ... | 180 | ... | ¼ | ... | 18x16 | 53 | ... |
| "Hawkeye" | 104-B-1 | ... | 100 | ... | ¼ | ... | 18x16 | 53 | ... |
| "Hawkeye" | 104-B-2 | ... | 140 | ... | ¼ | 52 | 18x16 | 53 | ... |
| "Hawkeye" | 104-B-3 | ... | 180 | ... | ¼ | 52 | 18x16 | 53 | ... |
| "Hawkeye" | 104-C-1 | ... | 100 | ... | ¼ | 53 | 39x23 | 56 | ... |
| "Hawkeye" | 104-C-2 | ... | 140 | ... | ¼ | 53 | 39x23 | 56 | ... |
| "Hawkeye" | 104-C-3 | ... | 180 | ... | ¼ | 53 | 39x23 | 56 | ... |
| Note—The above pumps can also be used for shallow wells. | | | | | | | | | |
| **The Dayton Pump & Mfg. Co., Dayton, Ohio** | | | | | | | | | |
| "Dayton" | Junior | 2 | 124 | 125 | ¼ | Any | .... | .... | .... |
| "Dayton" | Junior | 2 | 168 | 75 | ¼ | Any | .... | .... | .... |
| "Dayton" | Junior | 3½ | 193 | 60 | ¼ | Any | .... | .... | .... |
| "Dayton" | Junior | 2½ | 212 | 35 | ¼ | Any | .... | .... | .... |
| "Dayton" | 6" Stroke | 2 | 137 | 175 | ½ | Any | .... | .... | .... |
| "Dayton" | 6" Stroke | 2 | 187 | 125 | ½ | Any | .... | .... | .... |
| "Dayton" | 6" Stroke | 3½ | 215 | 100 | ½ | Any | .... | .... | .... |
| "Dayton" | 6" Stroke | 2½ | 245 | 75 | ½ | Any | .... | .... | .... |
| "Dayton" | 6" Stroke | 4 | 309 | 50 | ½ | Any | .... | .... | .... |
| "Dayton" | 6" Stroke | 3 | 382 | 30 | ½ | Any | .... | .... | .... |
| "Dayton" | 8" Stroke | 3¼ | 250 | 300 | 2 | Any | .... | .... | .... |
| "Dayton" | 8" Stroke | 2½ | 326 | 175 | 2 | Any | .... | .... | .... |
| "Dayton" | 8" Stroke | 2¾ | 412 | 225 | 2 | Any | .... | .... | .... |
| "Dayton" | 8" Stroke | 3¼ | 616 | 140 | 2 | Any | .... | .... | .... |
| "Dayton" | 8" Stroke | 3½ | 734 | 110 | 2 | Any | .... | .... | .... |
| "Dayton" | 8" Stroke | 3¾ | 866 | 90 | 2 | Any | .... | .... | .... |
| "Dayton" | 8" Stroke | 4¼ | 1,147 | 50 | 2 | Any | .... | .... | .... |
| "Dayton" | 8" Stroke | 6 | 1,473 | 30 | 2 | Any | .... | .... | .... |
| "Dayton" | 12" Stroke | 3¼ | 337 | 500 | 3 | Any | .... | .... | .... |
| "Dayton" | 12" Stroke | 4 | 557 | 325 | 3 | Any | .... | .... | .... |
| "Dayton" | 12" Stroke | 4½ | 832 | 220 | 3 | Any | .... | .... | .... |
| "Dayton" | 12" Stroke | 5 | 1,163 | 150 | 3 | Any | .... | .... | .... |
| "Dayton" | 12" Stroke | 5⅝ | 1,548 | 80 | 3 | Any | .... | .... | .... |
| "Dayton" | 12" Stroke | 6 | 1,988 | 40 | 3 | Any | .... | .... | .... |
| "Dayton" | 12" Stroke | 4½ | 832 | 300 | 5 | Any | .... | .... | .... |
| "Dayton" | 12" Stroke | 5 | 1,163 | 225 | 5 | Any | .... | .... | .... |
| "Dayton" | 12" Stroke | 5⅝ | 1,548 | 130 | 5 | Any | .... | .... | .... |
| "Dayton" | 12" Stroke | 6 | 1,988 | 100 | 5 | Any | .... | .... | .... |
| "Dayton" | 12" Stroke | 6¼ | 2,485 | 60 | 5 | Any | .... | .... | .... |
| **W. & B. Douglas, Middletown, Conn.** | | | | | | | | | |
| "Miracle" | 788C | 2 | 135 | 125 | ⅓ | 100 | .... | .... | 375 |
| "Miracle" | 7881 | 2 | 135 | 40 | ¼ | Any | .... | .... | 150 |
| "Miracle" | 7883 | 3½ | 180 | 100 | ⅓ | Any | .... | .... | 160 |
| "Miracle" | 7884 | 4 | 300 | 150 | ½ | Any | .... | .... | 215 |
| "Miracle" | 7885 | 4½ | 450 | 150 | ¾ | Any | .... | .... | 260 |
| "Texas" | 608-1 | 4½ | 600 | 100 | 1 | Any | .... | .... | .... |
| "Texas" | 608-2 | 4½ | 900 | 150 | 2 | Any | .... | .... | .... |
| "Texas" | 608-2 | 6 | 1,800 | 100 | 3 | Any | .... | .... | .... |
| "Texas" | 608-3 | 6 | 2,700 | 200 | 6 | Any | .... | .... | .... |

## DEEP WELLS (Continued)

| Trade Name | Type of Model | Smallest Size of Well for Cap. Given Inches | Capacity Gallons Per Hour | Depth to Water Ft. | Motor H. P. | Tank Capacity | Floor Space Inches | Height Inches | Weight Boxed Lbs. |
|---|---|---|---|---|---|---|---|---|---|
| **The Duro Pump & Mfg. Company, Dayton, Ohio** | | | | | | | | | |
| Style 900 Deep Well Pump | | | | | | | | | |
| Pumps with Open Type Well Cylinders | | | | | | | | | |
| "Duro" | 930 | 3 | 130 | 100 | ⅓ | .... | 16x16 | 36 | .... |
| "Duro" | 940 | 3 | 130 | 200 | ½ | .... | 16x16 | 36 | .... |
| "Duro" | 942 | 3 | 130 | 300 | ¾ | .... | 16x16 | 36 | .... |
| "Duro" | 950 | 3½ | 225 | 40 | ⅓ | .... | 16x16 | 36 | .... |
| "Duro" | 960 | 3½ | 225 | 100 | ½ | .... | 16x16 | 36 | .... |
| "Duro" | 962 | 3½ | 225 | 200 | ¾ | .... | 16x16 | 36 | .... |
| "Duro" | 971 | 4½ | 325 | 35 | ½ | .... | 16x16 | 36 | .... |
| "Duro" | 972 | 4½ | 325 | 70 | ¾ | .... | 16x16 | 36 | .... |
| Pumps with Closed Type Well Cylinders | | | | | | | | | |
| "Duro" | 910 | 2 | 125 | 100 | ⅓ | .... | 16x16 | 36 | .... |
| "Duro" | 920 | 2 | 125 | 200 | ½ | .... | 16x16 | 36 | .... |
| "Duro" | 922 | 2 | 125 | 300 | ¾ | .... | 16x16 | 36 | .... |
| "Duro" | 980 | 3 | 250 | 75 | ½ | .... | 16x16 | 36 | .... |
| "Duro" | 981 | 3 | 250 | 150 | ¾ | .... | 16x16 | 36 | .... |
| "Duro" | 982 | 3½ | 365 | 50 | ¾ | .... | 16x16 | 36 | .... |
| Note—Above pumps equipped with 110 and 220-volt alternating current motors. | | | | | | | | | |
| Special Deep Well Pumps with Direct Current Motors for Farm Lighting Plants | | | | | | | | | |
| "Duro" | 925 | 2 | 125 | 100 | ¼ | .... | 16x16 | 36 | .... |
| "Duro" | 935 | 2 | 125 | 200 | ½ | .... | 16x16 | 36 | .... |
| "Duro" | 945 | 3 | 130 | 100 | ¼ | .... | 16x16 | 36 | .... |
| "Duro" | 955 | 3 | 130 | 200 | ½ | .... | 16x16 | 36 | .... |
| "Duro" | 965 | 3½ | 225 | 40 | ¼ | .... | 16x16 | 36 | .... |
| "Duro" | 975 | 3½ | 225 | 100 | ½ | .... | 16x16 | 36 | .... |
| Note—Above pumps equipped with 32-volt, 115- or 230-volt Direct Current Motors. | | | | | | | | | |
| Style 3,000, Deep Well Pump | | | | | | | | | |
| Pumps with Closed Type Well Cylinders | | | | | | | | | |
| "Duro" | 3,060 | 3 | 447 | 125 | 1 | .... | 19x19 | 50 | .... |
| "Duro" | 3,065 | 3 | 447 | 175 | 1½ | .... | 19x19 | 50 | .... |
| "Duro" | 3,070 | 3½ | 642 | 50 | 1 | .... | 19x19 | 50 | .... |
| "Duro" | 3,075 | 3½ | 642 | 100 | 1½ | .... | 19x19 | 50 | .... |
| "Duro" | 3,080 | 4 | 873 | 35 | 1 | .... | 19x19 | 50 | .... |
| "Duro" | 3,085 | 4 | 873 | 65 | 1½ | .... | 19x19 | 50 | .... |
| "Duro" | 3,090 | 4½ | 1,143 | 35 | 1½ | .... | 19x19 | 50 | .... |
| Pumps with Open Type Well Cylinders | | | | | | | | | |
| "Duro" | 3,005 | 3 | 233 | 300 | 1 | .... | 19x19 | 50 | .... |
| "Duro" | 3,010 | 3 | 233 | 500 | 1½ | .... | 19x19 | 50 | .... |
| "Duro" | 3,015 | 3½ | 350 | 150 | 1 | .... | 19x19 | 50 | .... |
| "Duro" | 3,020 | 3½ | 350 | 275 | 1½ | .... | 19x19 | 50 | .... |
| "Duro" | 3,025 | 4½ | 525 | 75 | 1 | .... | 19x19 | 50 | .... |
| "Duro" | 3,030 | 4½ | 525 | 125 | 1½ | .... | 19x19 | 50 | .... |
| "Duro" | 3,035 | 5 | 735 | 40 | 1 | .... | 19x19 | 50 | .... |
| "Duro" | 3,040 | 5 | 735 | 75 | 1½ | .... | 19x19 | 50 | .... |
| "Duro" | 3,045 | 6 | 980 | 40 | 1½ | .... | 19x19 | 50 | .... |
| **Flint & Walling Mfg. Co., Kendallville, Indiana** | | | | | | | | | |
| "Hoosier" | 1355 | 2 | 135 | 40 | ¼ | Any | 12x22 | 24 | 120 |
| "Hoosier" | 1355 | 2 | 90 | 115 | ¼ | Any | 12x22 | 24 | 120 |
| "Hoosier" | 1360 | 2 | 220 | 40 | ½ | Any | 15x35 | 33 | 142 |
| "Hoosier" | 1360 | 2 | 150 | 120 | ½ | Any | 15x35 | 33 | 142 |
| **Fort Wayne Eng. & Mfg. Co., Fort Wayne, Indiana** | | | | | | | | | |
| "Paul" | HM-R 50 | 2 | 150 | 100 | ½ | 52 | 30x30 | 52 | 600 |
| "Paul" | HM-J 50 | 2½ | 200 | 60 | ½ | 120 | 30x40 | 77 | 625 |

# DEEP WELLS (Continued)

| Trade Name | Type of Model | Smallest Size of Well for Cap. Given Inches | Capacity Gallons Per Hour | Depth to Water Ft. | Motor H. P. | Tank Capacity | Floor Space Inches | Height Inches | Weight Boxed Lbs. |
|---|---|---|---|---|---|---|---|---|---|
| **Fort Wayne Engineering & Mfg. Co., Ft. Wayne, Ind. (Continued)** | | | | | | | | | |
| "Paul" | HM-K 50 | 2½ | 200 | 60 | ½ | 220 | 38x45 | 77 | 825 |
| "Paul" | HM-L 50 | 3 | 250 | 40 | ½ | 315 | 42x45 | 77 | 1,000 |
| "Paul" | HM-P 50 | 4 | 250 | 50 | ½ | 630 | .... | .. | 1,500 |
| "Paul" | HM-Q 50 | 4 | 250 | 50 | ½ | 1,000 | .... | .. | 2,300 |
| "Paul" | HM-R 51 | 2 | 165 | 150 | ¾ | 140 | 30x40 | 77 | 890 |
| "Paul" | HM-S 51 | 2½ | 275 | 80 | ¾ | 220 | 38x45 | 77 | 1,050 |
| "Paul" | HM-T 51 | 3 | 410 | 50 | ¾ | 315 | 42x45 | 77 | 1,175 |
| "Paul" | HM-U 51 | 3 | 410 | 50 | ¾ | 630 | .... | .. | 1,620 |
| "Paul" | HM-R 53 | 3 | 365 | 100 | 1 | 220 | .... | .. | 1,050 |
| "Paul" | HM-S 53 | 3½ | 448 | 70 | 1 | 315 | .... | .. | 1,200 |
| "Paul" | HM-U 53 | 3½ | 448 | 70 | 1 | 630 | .... | .. | 1,700 |
| "Paul" | HM-V 53 | 4 | 543 | 70 | 1 | 1,000 | .... | .. | 2,450 |
| "Paul" | HM-R 54 | 4 | 615 | 210 | 2 | 365 | .... | .. | 1,700 |
| "Paul" | HM-S 54 | 4½ | 865 | 140 | 2 | 630 | .... | .. | 2,100 |
| "Paul" | HM-T 54 | 4½ | 865 | 140 | 2 | 1,000 | .... | .. | 2,900 |
| "Paul" | HM-U 54 | 5 | 1,310 | 50 | 2 | 1,500 | .... | .. | 3,600 |
| "Paul" | HM-V 54 | 6 | 1,150 | 90 | 2 | 1,880 | .... | .. | 5,000 |
| "Paul" | HM-R 56 | 4 | 740 | 300 | 3 | 630 | .... | .. | 2,200 |
| "Paul" | HM-S 56 | 4½ | 1,035 | 210 | 3 | 1,000 | .... | .. | 3,000 |
| "Paul" | HM-T 56 | 4½ | 1,035 | 210 | 3 | 1,500 | .... | .. | 3,700 |
| "Paul" | HM-U 56 | 5 | 1,770 | 70 | 3 | 1,880 | .... | .. | 5,100 |
| "Paul" | HM-V 56 | 6 | 1,375 | 50 | 3 | 2,260 | .... | .. | 5,800 |
| Note—Special deep well pump systems for farm lighting plants. Specifications on application. | | | | | | | | | |
| **The Goulds Mfg. Co., Seneca Falls, N. Y.** | | | | | | | | | |
| "Autowater" | Fig. 1697 | 3½ | 150 | 50 | ¼ | No tank | 40x15 | 25 | 250 |
| **Kewanee Private Utilities Co., Kewanee, Ill.** | | | | | | | | | |
| "Kewanee" | 9A | 2 | 156 | 100 | ½ | 220 | 24x30 | 41 | 400 |
| "Kewanee" | 9B | 2 | 156 | 150 | ½ | 220 | 24x30 | 41 | 450 |
| "Kewanee" | 9C | 3 | 315 | 150 | 1 | 420 | 24x30 | 41 | 450 |
| "Kewanee" | 34A | 3 | 550 | 100 | 1 | 720 | 24x33 | 41 | 700 |
| "Kewanee" | 34C | 3½ | 550 | 200 | 2 | 550 | 24x33 | 41 | 750 |
| "Kewanee" | 34D | 3½ | 770 | 100 | 2 | 1,000 | 24x33 | 41 | 750 |
| "Kewanee" | 34E | 4 | 770 | 150 | 2 | 1,000 | 24x33 | 41 | 750 |
| **Leader Trahern Products Co., Decatur & Rockford, Ill.** | | | | | | | | | |
| "Leader" | Fig. 5 Jr. 560⅓ M | 2 | 161 | 50 | ⅓ | Any | 11½x38 | 22 | 300 |
| "Leader" | Fig. 5 Jr. 560½ M | 2½ | 247 | 25 | ½ | Any | 11½x38 | 22 | 325 |
| "Leader" | Fig. 5-6" No. 60½ MA | 2 | 161 | 50 | ½ | Any | 17 x48 | 29 | 440 |
| "Leader" | Fig. 5-6" No. 60½ MB | 2½ | 247 | 25 | ½ | Any | 17 x48 | 29 | 440 |
| "Leader" | Fig. 5-6" No. 61 MA | 2 | 161 | 250 | 1 | Any | 17 x60 | 29 | 480 |
| "Leader" | Fig. 5-6" No. 61 MB | 2½ | 247 | 175 | 1 | Any | 17 x60 | 29 | 480 |
| "Leader" | Fig. 5-6" No. 61 MC | 3 | 370 | 125 | 1 | Any | 17 x60 | 29 | 480 |
| "Leader" | Fig. 5-10" No. 101 MA | 2 | 333 | 50 | 1 | Any | 20 x60 | 34 | 685 |
| "Leader" | Fig. 5-10" No. 101 MB | 2½ | 412 | 100 | 1 | Any | 20 x60 | 34 | 685 |
| "Leader" | Fig. 5-10" No. 102 MA | 2½ | 309 | 200 | 2 | Any | 20 x60 | 34 | 775 |
| "Leader" | Fig. 5-10" No. 102 MB | 3 | 618 | 100 | 2 | Any | 20 x60 | 34 | 775 |
| "Leader" | Fig. 5-10" No. 102 MC | 3½ | 1,077 | 50 | 2 | Any | 20 x60 | 34 | 775 |
| "Leader" | Fig. 5-10" No. 103 MA | 3 | 771 | 75 | 3 | Any | 20 x72 | 34 | 785 |
| "Leader" | Fig. 5-10" No. 103 MB | 3½ | 861 | 100 | 3 | Any | 20 x72 | 34 | 785 |
| "Leader" | Fig. 5-10" No. 103 MC | 4 | 1,434 | 50 | 3 | Any | 20 x72 | 34 | 785 |
| **Mast, Foos & Co., Springfield, Ohio** | | | | | | | | | |
| "Buckeye" | 1,013 | 2 | 135 | 50 | ¼ | Any | .... | .... | .... |
| "Buckeye" | 2,194 | 2 | 215 | 100 | ¾ | Any | .... | .... | .... |
| "Buckeye" | 2,194 | 2½ | 360 | 100 | 1 | Any | .... | .... | .... |
| "Buckeye" | 2,194 | 3 | 550 | 100 | 1½ | Any | .... | .... | .... |

# DEEP WELLS (Continued)

| Trade Name | Type of Model | Smallest Size of Well for Cap. Given Inches | Capacity Gallons Per Hour | Depth to Water Ft. | Motor H. P. | Tank Capacity | Floor Space Inches | Height Inches | Weight Boxed Lbs. |
|---|---|---|---|---|---|---|---|---|---|
| | | | **Mast, Foos & Co., Springfield, Ohio (Continued)** | | | | | | |
| "Buckeye" | 2,195 | 3 | 690 | 100 | 2 | Any | .... | .... | .... |
| "Buckeye" | 2,195 | 3½ | 960 | 100 | 2½ | Any | .... | .... | .... |
| "Buckeye" | 2,195 | 4 | 1,285 | 100 | 3 | Any | .... | .... | .... |
| "Buckeye" | 2,195 | 5 | 2,050 | 50 | 3 | Any | .... | .... | .... |
| "Buckeye" | 143 | 4 | 1,575 | 200 | 5 | Any | .... | .... | .... |
| "Buckeye" | 143 | 5 | 2,295 | 150 | 5 | Any | .... | .... | .... |
| | | | **The Monarch Engineering Co., Dayton, Ohio** | | | | | | |
| "Monarch" | No. 714 | 1 13/16 | 120 | Not over 70 | ⅓ | .... | .... | .... | .... |
| "Monarch" | No. 724 | 2¾ | 275 | Not over 25 | ½ | .... | .... | .... | .... |
| "Monarch" | No. 724 | 2¼ | 185 | Not over 80 | ½ | .... | .... | .... | .... |
| "Monarch" | No. 724 | 1 13/16 | 120 | Not over 150 | ½ | .... | .... | .... | .... |
| "Monarch" | No. 726 | 2¼ | 278 | Not over 35 | ½ | .... | .... | .... | .... |
| "Monarch" | No. 726 | 1 13/16 | 175 | Not over 100 | ½ | .... | .... | .... | .... |
| "Monarch" | No. 734 | 3¼ | 385 | Not over 60 | ¾ | .... | .... | .... | .... |
| "Monarch" | No. 734 | 2¾ | 275 | Not over 125 | ¾ | .... | .... | .... | .... |
| "Monarch" | No. 734 | 2¼ | 185 | Not over 225 | ¾ | .... | .... | .... | .... |
| "Monarch" | No. 734 | 1 13/16 | 120 | Not over 360 | ¾ | .... | .... | .... | .... |
| "Monarch" | No. 736 | 2¾ | 416 | Not over 50 | ¾ | .... | .... | .... | .... |
| "Monarch" | No. 736 | 2¼ | 278 | Not over 125 | ¾ | .... | .... | .... | .... |
| "Monarch" | No. 736 | 1 13/16 | 175 | Not over 250 | ¾ | .... | .... | .... | .... |
| "Monarch" | No. 738 | 2¾ | 493 | Not over 25 | ¾ | .... | .... | .... | .... |
| "Monarch" | No. 738 | 2¼ | 330 | Not over 80 | ¾ | .... | .... | .... | .... |
| "Monarch" | No. 738 | 1 13/16 | 207 | Not over 200 | ¾ | .... | .... | .... | .... |
| "Monarch" | No. 744 | 3¾ | 515 | Not over 60 | 1 | .... | .... | .... | .... |
| "Monarch" | No. 744 | 3¼ | 385 | Not over 135 | 1 | .... | .... | .... | .... |
| "Monarch" | No. 744 | 2¾ | 275 | Not over 200 | 1 | .... | .... | .... | .... |
| "Monarch" | No. 744 | 2¼ | 185 | Not over 350 | 1 | .... | .... | .... | .... |
| "Monarch" | No. 744 | 1 13/16 | 120 | Not over 600 | 1 | .... | .... | .... | .... |
| "Monarch" | No. 746 | 3¼ | 581 | Not over 50 | 1 | .... | .... | .... | .... |
| "Monarch" | No. 746 | 2¾ | 416 | Not over 100 | 1 | .... | .... | .... | .... |
| "Monarch" | No. 746 | 2¼ | 278 | Not over 200 | 1 | .... | .... | .... | .... |
| "Monarch" | No. 746 | 1 13/16 | 175 | Not over 350 | 1 | .... | .... | .... | .... |
| "Monarch" | No. 748 | 3¼ | 680* | Not over 30 | 1 | .... | .... | .... | .... |
| "Monarch" | No. 748 | 2¾ | 493* | Not over 75 | 1 | .... | .... | .... | .... |
| "Monarch" | No. 748 | 2¼ | 330* | Not over 150 | 1 | .... | .... | .... | .... |
| "Monarch" | No. 748 | 1 13/16 | 207* | Not over 250 | 1 | .... | .... | .... | .... |
| "Monarch" | No. 766 | 3¾ | 774* | Not over 80 | 1½ | .... | .... | .... | .... |
| "Monarch" | No. 766 | 3¼ | 581* | Not over 135 | 1½ | .... | .... | .... | .... |
| "Monarch" | No. 766 | 2¾ | 416* | Not over 250 | 1½ | .... | .... | .... | .... |
| "Monarch" | No. 766 | 2¼ | 278* | Not over 400 | 1½ | .... | .... | .... | .... |
| "Monarch" | No. 766 | 1 13/16 | 175* | Not over 650 | 1½ | .... | .... | .... | .... |
| "Monarch" | No. 768 | 3¾ | 1,032* | Not over 30 | 1½ | .... | .... | .... | .... |
| "Monarch" | No. 768 | 3¼ | 690* | Not over 100 | 1½ | .... | .... | .... | .... |
| "Monarch" | No. 768 | 2¾ | 493* | Not over 200 | 1½ | .... | .... | .... | .... |
| "Monarch" | No. 768 | 2¼ | 330* | Not over 300 | 1½ | .... | .... | .... | .... |
| "Monarch" | No. 768 | 1 13/16 | 207* | Not over 500 | 1½ | .... | .... | .... | .... |

* In computing gallons per hour, a deduction of 10 to 25 per cent. must be made, as the figures given above are the well cylinder displacement. This varies according to depth of well, resistance and condition of well cylinder.

| Trade Name | Type of Model | Smallest Size of Well for Cap. Given Inches | Capacity Gallons Per Hour | Depth to Water Ft. | Motor H. P. | Tank Capacity | Floor Space Inches | Height Inches | Weight Boxed Lbs. |
|---|---|---|---|---|---|---|---|---|---|
| | | | **Rider-Ericsson Engine Co., New York, N. Y.** | | | | | | |
| "R. D. W" | 62-A-1 | 1½ | 115 | 240 | ⅓ | Any | 52x30 | 44 | 715 |
| "R. D. W." | 62-A-2 | 2 | 265 | 160 | ½ | Any | 52x30 | 44 | 745 |
| "R. D. W." | 62-A-3 | 2½ | 410 | 160 | ¾ | Any | 52x30 | 44 | 770 |
| "R. D. W." | 62-A-4 | 3 | 610 | 140 | 1 | Any | 52x30 | 44 | 800 |
| "R. D. W." | 62-A-5 | 3½ | 830 | 120 | 1½ | Any | 52x30 | 44 | 645 |
| "R. D. W." | 65-A-1 | 2½ | 490 | 200 | 1½ | Any | 30x60 | 47 | 1,145 |

# DEEP WELLS (Continued)

| Trade Name | Type of Model | Smallest Size of Well for Cap. Given Inches | Capacity Gallons Per Hour | Depth to Water Ft. | Motor H. P. | Tank Capacity | Floor Space Inches | Height Inches | Weight Boxed Lbs. |
|---|---|---|---|---|---|---|---|---|---|
| | **Rider-Ericsson Engine Co., New York, N. Y. (Continued)** | | | | | | | | |
| "R. D. W." | 65-A-2 | 3 | 730 | 200 | 2 | Any | 30x60 | 47 | 1,190 |
| "R. D. W." | 65-A-3 | 3½ | 1,020 | 200 | 3 | Any | 30x60 | 47 | 1,265 |
| "R. D. W." | 65-A-4 | 4½ | 1,800 | 165 | 5 | Any | 30x60 | 47 | 1,375 |
| "R. D. W." | 67-A-1 | 2½ | 490 | 200 | 1½ | Any | 30x30 | 47 | 1,245 |
| "R. D. W." | 67-A-2 | 3 | 730 | 200 | 2 | Any | 30x30 | 47 | 1,290 |
| "R. D. W." | 67-A-3 | 3½ | 1,020 | 200 | 3 | Any | 30x30 | 47 | 1,365 |
| "R. D. W." | 67-A-4 | 4½ | 1,800 | 200 | 5 | Any | 30x60 | 47 | 1,460 |
| | Max. head in ft. | | 5,000 lb. | | plunger load | 3,000 lb. | 46x50 | 72 | 2,600 |
| "R. D. W." | 66 | 3½ | 1,200 | | 1,400′ | 850′ | 46x50 | 72 | 2,600 |
| "R. D. W." | 66 | 4 | 1,600 | | 1,100′ | 650′ | | | |
| "R. D. W." | 66 | 4½ | 2,060 | | 840′ | 500′ | | | |
| "R. D. W." | 66 | 5 | 2,560 | | 660′ | 400′ | | | |
| "R. D. W." | 66 | 5½ | 3,150 | | 560′ | 330′ | | | |
| "R. D. W." | 66 | 6 | 3,775 | | 450′ | 270′ | | | |

## AIR LIFT OR PNEUMATIC WATER SUPPLY SYSTEMS

| Trade Name | Name and Address of Manufacturer |
|---|---|
| "Andrew's" | Andrews Heating Co., Minneapolis, Minn. |
| | Baltimore Cooperage Co., Baltimore, Md. |
| "Ideal" | Bennett Brothers Co., Lowell, Mass. |
| | Butler Company, Butler, Ind. |
| | Carter Co., R. B., 152 Chambers St., New York. |
| | Celina Mfg. Co., Celina, Ohio. |
| | Chicago Bridge & Iron Wks., Chicago, Ill. |
| | Chicago Pneumatic Tool Co., Chicago, Ill. |
| | Economy Pumping Machinery Co., Chicago, Ill. |
| | Fairbanks Co., 416 Broome St., New York. |
| | **Fairbanks-Morse & Co., Chicago, Ill.** |
| "Neptune" | Fleck Brothers Co., Philadelphia, Pa. |
| | Harris Air Pump Co., Indianapolis, Ind. |
| "Nocost" | Illinois Pump & Brass Co., Peoria, Ill. |
| | Indiana Air Pump Co., Indianapolis, Ind. |
| | Ingersoll-Rand Co., 11 Broadway, New York. |
| | Layne & Bowler, Memphis, Tenn. |
| "Leader" | Leader Iron Wks., Decatur, Ill. |
| | Luitwieler Pumping Engine Co., Rochester, N. Y. |
| | Lunt-Moss Co., Boston, Mass. |
| | McDonald Mfg. Co., A. Y., Dubuque, Ia. |
| | Murphy & Walsh, Pekin, Ill. |
| | Myers & Brother, F. E., Ashland, Ohio. |
| "National" | National Steel Tank & Mfg. Co., Bradford, Ill. |
| | Pacific Pump & Supply Co., San Francisco, Cal. |
| | Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa. |
| | Quick & Thomas Co., Auburn, N. Y. |
| "Superior" | Sloan & Co., Rochester, N. Y. |
| | Weber Subterranean Pump Co., 50 E. 42nd St., New York. |
| | Woodmansee Mfg. Co., Freeport, Ill. |

## WATER WHEELS AND TURBINES

| Trade Name | Name and Address of Manufacturer |
|---|---|
| **"Allis-Chalmers"** | **Allis-Chalmers Mfg. Co., Milwaukee, Wis.** |
| "Moline-McCormick" | Barnard & Leas Mfg. Co., Moline, Ill. |
| "Watertight" | Bartley & Sons, Wm., Bartley, N. J. |
| | Blake & Son, H., East Pepperell, Mass. |
| | Blymer Iron Works Co., Cincinnati, O. |
| | Turbine Mfg. Co., Orange, Mass. |
| "C M. C." | Christiana Machine Co., Christiana, Pa. |
| | Davis Foundry & Machine Works, Rome, Ga. |
| | Dayton Globe Iron Works Co., Dayton, O. |
| | DeLoach Mill Mfg. Co., Bridgeport, Ala. |
| | Ephrata Foundry & Machine Works, Ephrata, Pa. |
| | Eyster, Weiser & Co., York, Pa. |
| **"Fitz"** | **Fitz Water Wheel Co., Hanover, Pa.** |
| | Gerdes & Co., New York, N. Y. |
| | Hallidie Co., Spokane, Wash. |
| | Hendy, Joshua Iron Works, San Francisco, Cal. |
| "Hercules" | Holyoke Machine Co., Worcester, Mass. |
| "I. X. L.," "X. L. C. R." | Humphrey Machine Co., Keene, N. H. |
| "Hunt-McCormick" | Hunt, Rodney Machine Co., Orange, Mass. |
| | Jolly, J. & W., Holyoke, Mass. |
| | Knight & Co., Sutter Creek, Cal. |
| "Leffel" | Leffell & Co., J., Springfield, O. |
| "Monitor" | Lane Mfg. Co., Montpelier, Vt. |
| "De Remer" | Mine & Smelter Supply Co., 42 Broadway, New York. |
| "Francis," "Girard" | Morris Company, I. P., Philadelphia, Pa. |
| "Little Giant" | Munson Mill Machinery Co., Utica, N. Y. |
| "Pelton" | Pelton Water Wheel Co., San Francisco, Cal. |
| "Frances," "Victor" | Platt Iron Works Company, Dayton, O. |
| | Poole Engineering & Mach'y Co., Baltimore, Md. |
| "Ajax" | Salem Foundry & Machine Works, Salem, Va. |
| | Savage Company, W. J., Knoxville, Tenn. |
| | Sergeant Mfg. Co., Greensboro, N. C. |
| "McCormick," "New Success," "Smith" | Smith S. Morgan Co., York, Pa. |
| | Trump Mfg. Co., Springfield, O. |
| | Tuerk Water Motor Co., Chicago, Ill. |
| "Tuthill" | United Iron Works, Oakland, Cal. |
| | Walker Mfg. Co., Denver, Col. |
| | Wellman-Seaver-Morgan Co., Cleveland, O. |
| "Keiser," "Wolf" | Wolf Co., Chambersburg, Pa. |

## WATT HOUR METERS

| | |
|---|---|
| "Duncan" | Duncan Electric Mfg. Co., Lafayette, Ind. |
| | General Electric Co., Schenectady, N. Y. |
| | Roller-Smith Co., 233 Bway., New York. |
| "Sangamo" | Sangamo Electric Co., Springfield, Ill. |
| | **Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.** |

## WINDMILLS AND WIND DRIVEN ELECTRIC PLANTS

| | |
|---|---|
| "Aermotor"* | Aermotor Company, Chicago, Ill. |
| | Althouse-Wheeler Company, Waupun, Wis. |
| "Goodhue" | Appleton Manufacturing Co., Batavia, Ill. |
| | Baltimore Cooperage Company, Baltimore, Md. |
| "Monitor" | Baker Manufacturing Company, Evansville, Wis. |
| "B-B" | Beckman Brothers, Des Moines, Ia. |
| | Breyer Brothers, Waupun, Wis. |
| | Butler Company, Butler, Ind. |
| | Caldwell, W. E., Louisville, Ky. |
| "Monarch" | Celina Manufacturing Company, Celina, O. |
| "Challenge," "Dandy" | Challenge Company, Batavia, Ill. |
| | Church, Stephen, B., Seymour, Conn. |
| | Corcoran, Inc., A. J., Jersey City, N. J. |
| | Currie Wind Mill Company, Topeka, Kans. |
| | Dempster Manufacturing & Supply Co., Des Moines, Ia. |
| "Duplex," "Superior" | Duplex Mfg. Company, Superior, Wis. |
| | Elgin Wind Power & Pump Company, Elgin, Ill. |
| **"Eclipse," 'Fairbanks-Morse"** | **Fairbanks-Morse & Co., Chicago, Ill.** |
| "Star" | Flint & Walling Mfg. Co., Kendallville, Ind. |

## WINDMILLS AND WIND DRIVEN ELECTRIC PLANTS (Continued)

| Trade Name | Name and Address of Manufacturers |
|---|---|
| | Freeman Manufacturing Company, Racine, Wis. |
| "Baker" | Heller-Aller Company, Napoleon, O. |
| | Horicon Wind Mill Company, Horicon, Wis. |
| | Ideal Engine Company, Lansing, Mich. |
| | Iowa Wind Mill & Pump Co., Cedar Rapids, Ia. |
| | Jackson Byron Iron Works, Berkeley, Cal. |
| | Kalamazoo Tank & Silo Co., Kalamazoo, Mich. |
| | Kregel Windmill Company, Nebraska City, Neb. |
| | Krogh Pump & Machinery Co., San Francisco, Cal. |
| | Leach Windmill & Tank Co., Joliet, Ill. |
| | McDaniel & Son, Litchfield, Ill. |
| "Imperial" | Mast, Foos & Company, Springfield, O. |
| | Mt. Pulaski Wind Mill Co., Mt. Pulaski, Ill. |
| | Northwestern Wind Engine Co., Minneapolis, Minn. |
| | Pacific Pump & Supply Co., San Francisco, Cal. |
| **"Aerolectric"*** | **Perkins Corp., Mishawaka, Ind.** |
| "I. X. L." | Phelps & Bigelow Windmill Co., Kalamazoo, Mich. |
| "Samson" | Portable Elevator Mfg. Co., Bloomington, Ill. |
| | Rawleigh, W. T., Freeport, Ill. |
| | Reader, J. B., Delavan, Wis. |
| | Red Cross Manufacturing Co., Bluffton, Ind. |
| | Red King Company, Wauseon, O. |
| | Rork Mfg. Co., M. D., Lansing, Mich. |
| | Sandwich Manufacturing Company, Sandwich, Ill. |
| "Eureka" | Smith & Pomeroy Windmill Co., Kalamazoo, Mich. |
| | Southern Rock Island Plow Co., Dallas, Tex. |
| "Samson"* | Stover Mfg. & Engine Co., Freeport, Ill. |
| | U. S. Supply Co., Omaha, Neb. |
| "Halladay" | U. S. Wind Engine & Pump Co., Batavia, Ill. |
| "Baldwin" | Walker Manufacturing Company, Council Bluffs, Ia. |
| "Aerolite"* | Wind Electric Co., Minneapolis, Minn. |
| | Winter Company, F. W., Faribault, Minn. |
| "Blue Star" | Wistrand Manufacturing Co., Galva, Ill. |
| | Woodin & Little, San Francisco, Cal. |
| "Fritschle"* | Woodmanse Manufacturing Co., Freeport, Ill. |

*Wind-driven farm light and power plant.

## WIRE AND CABLE

### Rubber Covered Wire—Cord—Cable

| | |
|---|---|
| | A-A Wire Company, Newark, N. J. |
| | Acorn Insulated Wire Company, Brooklyn, N. Y. |
| "Americore" | American Steel & Wire Co., Chicago, Ill. |
| "Amerite" | American Steel & Wire Co., Chicago, Ill. |
| "Crown" | American Steel & Wire Co., Chicago, Ill. |
| "Globe" | American Steel & Wire Co., Chicago, Ill. |
| "Reliance" | American Steel & Wire Co., Chicago, Ill. |
| "W. & M" | American Steel & Wire Co., Chicago, Ill. |
| "Amelectric" | American Electrical Works, Philipsdale, R. I. |
| | Astoria Wire Company, Astoria, L. I., N. Y. |
| "Dolphin" | Atlantic Insulated Wire & Cable Co., New York, N. Y. |
| "Neptune" | Atlantic Insulated Wire & Cable Co., New York, N. Y. |
| "Triton" | Atlantic Insulated Wire & Cable Co., New York, N. Y. |
| | Bay State Insulated Wire & Cable Co., Hyde Park, Mass. |
| "Beldenite" | Belden Manufacturing Company, Chicago, Ill. |
| "Belden 30" | Belden Manufacturing Company, Chicago, Ill. |
| "Calumet" | Belden Manufacturing Company, Chicago, Ill. |
| "Balta" | Bishop Gutta Percha Company, New York, N. Y. |
| "Paraxel" | Bishop Gutta Percha Company, New York, N. Y. |
| | Boston Insulated Wire & Cable Co., Boston, Mass. |
| "Star" | Bourn Rubber Company, Providence, R. I. |
| "I. X. L." | Collyer Insulated Wire Co., Pawtucket, R. I. |
| "Imperial" | Crescent Insulated Wire & Cable Co., Trenton, N. J. |
| | Detroit Insulated Wire Company, Detroit, Mich. |
| "Wovenite" | Flexible Woven Cable Company, Boston, Mass. |
| | General Electric Company, Schenectady, N. Y. |
| "Wizard" | Gottschalk Mfg. Company, J. W., Philadelphia, Pa. |
| "Ecco" | Habirshaw Electric Cable Company, Yonkers, N. Y. |
| "Engineers" | Habirshaw Electric Cable Company, Yonkers N. Y. |
| "Habirlite" | Habirshaw Electric Cable Company, Yonkers, N. Y. |

## WIRE AND CABLE

### Rubber Covered Wire—Cord—Cable (Continued)

| Trade Name | Name and Address of Manufacturer |
|---|---|
| "Invincible" | Habirshaw Electric Cable Company, Yonkers, N. Y. |
| "Security" | Habirshaw Electric Cable Company, Yonkers, N. Y. |
| "Signet" | Habirshaw Electric Cable Company, Yonkers, N. Y. |
| "Penn." | Hazard Manufacturing Company, Wilkes-Barre, Pa. |
| "Paramite" | Indiana Rubber & Insulated Wire Co., Jonesboro, Ind. |
| | Kerite Insulated Wire & Cable Co., New York, N. Y. |
| | Lowell Insulated Wire Company, Lowell, Mass. |
| "Eagle" | Marion Insulated Wire & Rubber Co., Marion, Ind. |
| | McEvoy, C. H., Lowell, Mass. |
| "Paracore" | National India Rubber Company, Bristol, R. I. |
| "Liberty" | National Metal Molding Company, Pittsburgh, Pa. |
| | New England Cable Company, Concord, N. H. |
| "Grimshaw" | New York Insulated Wire Co., New York, N. Y. |
| "Raven" | New York Insulated Wire Co., New York, N. Y. |
| | Okonite Company, Passaic, N. J. |
| | Packard Electric Company, Warren, Ohio |
| "Tronite" | Paragon Electric Company, Chicago, Ill. |
| | Philadelphia Insulated Wire Co., Philadelphia, Pa. |
| "Parac" | Phillips Wire Company, Pawtucket, R. I. |
| | Roebling's Sons Company, John, A., Trenton, N. J. |
| "Diamond" | Rome Wire Company, Rome, N. Y. |
| "Ruby Core" | Safety Insulated Wire & Cable Co., New York, N. Y. |
| "Caoutchouc" | Simplex Wire & Cable Company, Boston, Mass. |
| "Simcore | Simplex Wire & Cable Company, Boston, Mass. |
| "Sterling" | Standard Underground Cable Co., Pittsburgh, Pa. |
| "Tip Top" | Standard Underground Cable Co., Pittsburgh, Pa. |
| "Knit" | Triangle Conduit Company, Brooklyn, N. Y. |
| "Paracore" | United States Rubber Company, Bristol, R. I. |
| | **Western Electric Company, New York, N. Y.** |

### Asbestos Covered Wire

| | |
|---|---|
| | Belden Manufacturing Company, Chicago, Ill. |
| | D & W Fuse Works of General Electric Co., Providence, R. I. |
| | Driver-Harris Wire Company, Harrison, N. J. |
| | Rockbestos Products Corp., New Haven, Conn. |
| "Salamander" | York Insulated Wire Co. of General Electric Co., York, Pa. |

### Fish Wire

| | |
|---|---|
| | Austin Company, M. B., Chicago, Ill. |
| | Cary Spring Works, New York, N. Y. |
| "R. M. C." | Battan Manufacturing Company, New Haven, Conn. |
| "Superior" | Steel City Electric Company, Pittsburgh, Pa. |

### Fuse Wire

| | |
|---|---|
| | Bussmann Manufacturing Company, St. Louis, Mo. |
| "Shawmut" | Chase-Shawmut Company, Newburyport, Mass. |
| | Chicago Fuse Manufacturing Company, Chicago, Ill. |
| | General Electric Company, Schenectady, N. Y. |
| | **Killark Electric Manufacturing Company, St. Louis, Mo.** |

# CLOTHES WASHING MACHINES

| Trade Name | Name and Address of Manufacturer | Operating Principle | Material of Tub | Capacity Sheets | Dimensions (Inches) | Length Wringer Rolls (Inches) and Type | Motor H. P. | Motor Maker |
|---|---|---|---|---|---|---|---|---|
| "Air-Way" | Airway El. Appliance Corp., Toledo, Ohio............ | Oscil. Tub | (C) | 12 | 26 x28½ | 12-Swg. | ¼ | Own |
| "Butterfly" | Albaugh-Dover Co., Chicago, Ill..................... | Rotat. Tub | (C) | 16 | 24x30 | 12-Swg. | ⅙ | Dayton Fan & Motor Co. |
| "ABC Super-El" | Altorfer Bros. Co., Peoria, Ill. | Rotat. Cyl. | (C) | 6 | ......... | 11-Swg. | ¼ | Any |
| "ABC Alco" | " " " | Dolly | (W) | 6 | ......... | 11-Swg. | ¼ | Any |
| "Oscillator" | Amer. Gas Mach. Co....... | Vac. Cup | (W) | 10 | 12x26 | Swg. | ⅙ | Gen. Elec. |
| "Rightway" | Albert Lea, Minn.......... | Vac. Cup | (W) & (C) | 10 | 12x26 | Swg. | ⅙ | Gen. Elec. |
| "Apex" | Apex Appl. Co., Chicago, Ill. | Oscillating | (GS) | 6 | 29x30 | 11-Swg. | .... | (***) |
| "Apex" | " " " | Oscillating | (GS) | 9 | 29x32 | 12-Swg. | .... | (***) |
| "Apex" | " " " | Oscillating | (GS) | 15 | 29x30 | 14-Swg. | .... | (***) |
| 'Apex" | " " " | Oscillating | (C) | 6 | 29x32 | 11-Swg. | .... | (***) |
| "Apex" | " " " | Oscillating | (C) | 9 | 29x40 | 12-Swg. | .... | (***) |
| "Apex" | " " " | Oscillating | (C) | 15 | 29x40 | 14-Swg. | .... | (***) |
| "Rotarex" | Apex Elec. Distributing Co., | Revolving | (GS) | 7 | 22x24 | 12-Swg. | ¼ | Own |
| ""Rotar x" | Cleveland, Ohio.......... | Revolving | (C) | 7 | 22x24 | 12-Swg. | ¼ | Own |
| "Arora-Hart" | Arora Co., New York, N. Y. | Vac. Cup | (*) | 10–16 | ......... | Stat. | ⅙ to ¼ | Emer. El. |
| "At Last" | At Last Washer Co., Perry, | Dolly | (W) | 8 | ......... | 10-Stat. | ¼ | Westg. |
| "Kibby" | Iowa.................... | Dolly | (W) | 8 | ......... | 12-Swg. | ⅙ | Westg. |
| "Kibby's Power" | " " " | Dolly | (W) | ......... | ......... | 12-Swg. | ¼ | Westg. |
| "Auto. Washer" | Auto. Elec. Washer Co., | Dolly | (W) | 6 | ......... | 12-Swg. | ⅙ | Emer. Elec. |
| "Auto. Washer" | Newton, Iowa........... | Dolly | (C) | 6 | ......... | 12-Swg. | ⅙ | Emer. Elec. |
| "Big 3" | Barlow & Seelig Mfg. Co., | Vac. Cup | (C) | 4 | 20x20 | 11-Swg. | ⅙ | Emer. Elec. |
| "Big 3" | Ripon, Wis.............. | Vac. Cup | (C) | 4 | 20x20 | 12-Swg. | ⅙ | Emer. Elec. |
| "Beebe" | Beebe Products Co., Minneapolis, Minn............. | Vac. Cup | (W) | 6 | 24½x21½ | 11-Swg. | ⅙ | Gen. Elec. |
| "Aerobell" | Bell Washer & Wringer Co., Cleveland, Ohio.......... | Vac. Cup | (C) | 8 | 29x12 | 12-Swg. | ¼ | Gen. Elec. & R. & M. |
| "Berthold" | Berthold Elec. Mfg. Co., | Rotat. Cyl. | (C) | 8 | 23x24 | 12-Swg. | ¼ | Gen. Elec. |
| "Berthold" | Chicago, Ill.............. | Rotat. Cyl. | (C) | 8 | 23x24 | 12-Swg. | ¼ | Gen. Elec. |
| "Blackstone" | Blackstone Mfg. Co., James- | Dolly | (W) | ..... | 23x22 | 11-Swg. | ¼ | ............ |
| "Amer. Classic" | town, N. Y.............. | Cylinder | (GI) & (C) | 8 | 34½x25½ | 12 | ¼ | ............ |
| "Woman's Friend" | Bluffton Mfg. Co., Bluffton, Ohio.................... | Disc | (W) | 6 | 24x21 | 10-Stat. & 12-Sw. | ¼ | Gen. Elec. |
| "Boss No. 40" | Boss Wash. Mch. Co., Cin- | (**)Os. Cyl | (W) | 6 | 20x39 | (R) 12-Sw | ⅙ | Gen. Elec. |
| "Boss No. 50" | cinnati, Ohio............ | .......... | (W) | 6 | ......... | (R) 12-Sw | ⅙ | Gen. Elec. |
| "O. K." | H. F. Brammer Mfg. Co., | Dolly | (W) | 6 | 24x24 | 10-Stat. | ⅙ | Gen. Elec. |
| "O. K." | Davenport, Iowa......... | Dolly | (W) | 6 | 24x60 | 12-Stat. | ¼ | Gen. Elec. |
| "O. K." | " " " | Dolly (**) | (W) | 6 | 24x60 | 12-Swg. | ¼ | Gen. Elec. |
| "O. K." | " " " | Rotat. Cyl. | (GS) | 8 | 28x30 | 12-Swg. | ¼ | Gen. Elec. |
| "O. K." | " " " | .......... | (C) | 8 | 28x30 | 12-Swg. | ¼ | Gen. Elec. |
| "Prima" | Buckeye-Prima Co., Sidney, Ohio.................... | Oscil. Tub | (W) | 10 | 30x31 | 12-Swg. | ⅙ | Gen. Elec. |
| "Cadillac" | Cadillac Wash. Mch. Co., Chicago, Ill............. | Rotat. Cyl. | (C) | 6 | 22x24 | 11-Swg. | ¼ | Westg. |
| "Abso-Clean" | C. & D. Mfg. Corp., Detroit, Mich.................. | Vac. Cup | (C) | 10 | 27x28 | 12-Swg. | ¼ | Domes El. |
| "Camp" | Camp Mfg. Co., Washington, Ill..................... | Dolly | (W) | 6 | 12½x21 | Stat. | ¼ | Domes El. |
| "Humanity" | Central Mfg. Co., St. Louis, Mo..................... | Cylinder | (GS) & (C) | 10 | 22x18 | 12-Swg. | ¼ | Rob. & Myrs. |
| "Humanity" | " " " | Cylinder | (GS) & (C) | 14 | 22x24 | 12-Swg. | ¼ | Rob. & Myrs. |
| "Chicago" | Chicago Drier Co., Chicago, | Oscil. Tub | (C) | 9 | 26x34 | 12-Stat. | ⅙ | Cen. Elec. |
| "Chicago" | Ill...................... | Oscil. Tub | (C) | 12 | 26x37 | 14-Stat. | ⅙ | Cen. Elec. |
| "Chicago" | " " " | Oscil. Tub | (C) | 15 | 26x40 | 14-Stat. | ⅙ | Cen. Elec. |
| "Clarinda" | Clarinda Lawn Mower Co., Clarinda, Iowa........... | Dolly | (W) | 6 | 22x22 | 10-Swg. | ⅙ | Gen. Elec. |
| "Harmony" | Clark-Cadle-Harmon Corp., | Rotat. Cyl. | (GS) | 8 | 24x31 | 11-Swg. | ¼ | Westg. |
| "Harmony" | Rochester, N. Y.......... | Rotat. Cyl. | (C) | 8 | 24x31 | 11-Swg. | ¼ | Westg. |
| "Reliable" | Clements Mfg. Co., Chicago, Ill..................... | Oscil. Tub | (C) | 8 | ......... | 12 | ¼ | ............ |
| ............... | Coffield Wsh. Co., Dayton, O. | Oscil. Tub | (C) | 8 | 22x22 | 12-Swg. | ¼ | Gen. Elec. |
| "Common Sense" | Common Sense Co., Berkely, Calif.................... | Vac. Cup | (C) | 6 | ......... | 12-Slid. | ⅙ | Any |
| "Western Electric" | Conlon Elec. Washer Co., Cicero, Ill.............. | Reversing Cylinder | (GS) & (C) | 6 | 20x20¾ | 11 | ¼ | West. Elec. |
| ............... | Coffield Washer Co., Dayton, | Oscil. Cyl. | (C) | 8 | 22x22 | 12-Swg. | ¼ | Gen. Elec. |
| ............... | Ohio.................... | Oscil. Cyl. | (C) | 8 | 22x22 | 12-Swg. | ¼ | Gen. Elec. |
| "Crystal" | Crystal Washer Mch. Co., | Rotat. Cyl. | (GS) | 8 | 28x30 | 12-Swg. | ¼ | Domes Elec. |
| ............... | Detroit, Mich............ | Rotat. Cyl. | (C) | 8 | 28x30 | 12-Swg. | ¼ | Domes Elec. |
| "Blue Bird" | Davis Sewing Machine Co., Dayton, Ohio............ | Oscil. Tub | (C) | 8 | 24x27 | 12-Swg. | ¼ | Westg. |
| ............... | Dawn Mfg. Co., Bridgeport, Conn.................. | Vac. Cup | ..... | ..... | ......... | ......... | ⅙ | Gen. Elec. |
| "Delite" | Delite Mfg. Co., Bryan, Ohio | Dolly | (W) | 6 | 21x25 | 11-Swg. | ⅙ | Gen. Elec. |
| "Delite" | " " " | Dolly | (C) | 10 | 21x25 | 11-Swg. | ⅙ | Gen. Elec. |
| "Dexter" | Dexter Co., Fairfield, Iowa.. | Dolly | (W) or (C) | 5–10 | 27x47 | Swg. | ¼ | Emer. Elec. |
| "Duchess" | " " " | Dolly | (W) or (C) | 5 | 21x25 | Swg. | ⅙ | Emer. Elec. |
| 'Climax" | " " " | Dolly | (W) | 5 | 26x28 | Swg. | ¼ | Emer. Elec. |
| "Cruiser" | " " " | Vacuum | (W) | 5 | 26x28 | Swg. | ¼ | Emer. Elec. |
| "Packard" | " " " | Vacuum | (W) | 5 | 38x20 | Swg. | ¼ | Emer. Elec. |
| "Domestic" | Domes. Laundry Equipment Co., New York, N. Y..... | Oscil. Cyl. | (GS) or (C) | 20 | 60x33 | 14-Stat. | ¾ | Westg. |
| "Domestic" | " " " | Oscil. Cyl. | (GS) or (C) | 25 | 60x33 | 14-Stat. | 1 | Westg. |

## CLOTHES WASHING MACHINES (Continued)

| Trade Name | Name and Address of Manufacturer | Operating Principle | Material of Tub | Capacity Sheets | Dimensions (Inches) | Length Wringer Rolls (Inches) and Type | Motor H. P. | Motor Maker |
|---|---|---|---|---|---|---|---|---|
| "Klean Kwick" | Du Mond Mfg. Co., Cedar Falls, Iowa | Vac. Cup | (W) | 8 | ......... | 11-St. or Swg. | ¼ | Marathon |
| ............... | " " " | Vac. Cup | (GS) | 8 | 22x24 | 11-St. or Swg. | ¼ | Marathon |
| ............... | " " " | Vac. Cup | (C) | 8 | 22x24 | 11-St. or Swg. | ¼ | Marathon |
| "Easiest Way" | Easiest Way Mfg Co., Sandusky, Ohio | Dolly | (W) | 6 | 25x29 | 12-Swg. | ¼ | Westg. |
| ............... | " " " | Oscil. Tub | (C) | 8 | 29x35 | 12-Swg. | ¼ | Westg. |
| ............... | " " " | .......... | (GS) | .... | 29x35 | ....... | ... | .......... |
| "Bauer" | Faultless Washer Sales Co., Milwaukee, Wis | Rotat. Cyl. | (GS) | 8 | 24x25 | 12-Swg. | ¼ | Gen. Elec. |
| "Federal" | Federal El. Co., Chicago, Ill. | Oscillating | (GS) | 6 | 26x30 | Swg. | ¼ | Westg. |
| "Federal" | " " " | Oscillating | (C) | 6 | 26x40 | Swg. | ¼ | Westg. |
| "Federal" | " " " | Oscillating | (GS) | 12 | 25x40 | Swg. | ¼ | Westg. |
| "Federal" | " " " | Oscillating | (C) | 12 | 23x37 | Swg. | ¼ | Westg. |
| "Rainbow" | B. E. Finucane Co., Rochester, N. Y. | Ro at. Cyl. | (GS) | 6 | 25x34 | 11-Swg. | ¼ | Westg. |
| "Electro Thermo" | Fol om-Miller Co., Milwaukee, Wis | Rotat. Cyl. | (AI) | 6 | ......... | 12-Swg. | ¼ | Domes. El. |
| "New Liberty" | Fosston-Carpenter Co., St. Paul, Minn. | Rotat. Cyl. | (GS) | 8 | 27x30 | 12-Swg. | ¼ | Mar'thn El. |
| ............... | " " " | Rotat. Cyl. | (C) | 8 | ......... | 12-Swg. | ¼ | Mar'thn El. |
| "Royal" | P. A. Geier Co., Cl veland, O. | Vac. Cup | (*) | 5 | ......... | 12-Stat. | ⅙ | Domes. El. |
| "G. R. S." | General Railway Signal Co., Rochester, N. Y. | Rotat. Cyl. | (AI) | 8 | 25x30 | 12-Swg. | ¼ | Own |
| "G. R. S." | " " " | Rotat. Cyl. | (C) | 8 | 25x30 | 12-Swg. | ¼ | Own |
| "G. R. S." | " " " | Rotat. Cyl. | (AI) | 14 | 25x38 | 12-Swg. | ¼ | Own |
| "G. R. S." | " " " | Rotat. Cyl. | (C) | 14 | 25x38 | 12-Swg. | ¼ | Own |
| "Getz" | Getz Power Washer Co., Morton, Ill. | Rotat. Cyl. | (GS) & (AI) | 6 | 25x28 | 11-Swg. | ¼ | Gen. Elec. |
| "Getz" | " " " | Rotat. Cyl. | (C) | 6 | 25x28 | 11-Swg. | ¼ | Gen. Elec. |
| "Amer. Beauty" | " " " | Oscil. Cyl. | (C) | 8 | 26x28 | 11-Swg. | ¼ | Gen. Elec. |
| "Geyser" | Geyser Elec. Co., Chicago, Ill. | Rotat. Cyl. | (GS) | 3 | 17x17 | Stat. | ⅛ | ........... |
| "Geyser" | " " " | Rotat. Cyl. | (GS) | 6 | 21x22 | Swg. | ¼ | ........... |
| "Geyser" | " " " | Rotat. Cyl. | (GS) | 9 | 22x23 | Swg. | ¼ | ........... |
| "Geyser" | " " " | Rotat. Cyl. | (C) | 9 | 22x23 | Swg. | ¼ | ........... |
| "Geyser" | " " " | Rotat. Cyl. | (C) | 6 | 21x22 | Swg. | ¼ | ........... |
| "Eden" | Gillespie Eden Corp., New York, N. Y. | Rotat. Cyl. | (GS) | 8 | 23x24 | 12-Swg. | ⅙ | Rob. & Myrs. |
| "Eden" | " " " | Rotat. Cyl. | (C) | 8 | 23x24 | 12-Swg. | ⅙ | Rob. & Myrs. |
| "Eden" | " " " | Rotat. Cyl. | (GS) | 12 | 23x30 | 12-Swg. | ¼ | Rob. & Myrs. |
| "Eden" | " " " | Rotat. Cyl. | (C) | 12 | 23x30 | 12-Swg. | ¼ | Rob. & Myrs. |
| "Quicker Yet" | Globe Mfg. Co., Perry, Iowa. | Dolly(**) | (W) | 5 | 24x27 | 11-Swg. | ⅙ | Westg. |
| "Quicker Yet" | " " " | Dolly (TT) (**) | (W) | 10 | 24x48 | 11-Swg. | ¼ | Westg. |
| "Laundry Queen" | Grinnell Wash. Mch. Co., Grinnell, Iowa | Dolly | (W) | 6 | 24x26 | 11-Swg. | ⅙ | Emer. Westg. Gen. Elec. |
| "Laundry Queen" | " " " | Oscillating | (C) | 8 | ......... | ......... | ⅙ | Emer. Westg. Gen. Elec. |
| "Electric Maid" | " " " | Dolly | (C) | 6 | 24x26 | 11-Swg. | ⅙ | Emer. Westg. Gen. Elec. |
| "Haag" | Haag Bros. Co., Peoria, Ill. | Oscillating | (C) | 8 | ......... | 12-Swg. | ¼ | ........... |
| "Haag" | " " " | Cylinder | (AI) & (C) | 6 | ......... | 12-Swg. | ¼ | ........... |
| "Nuway" | " " " | Dolly | (W) & (C) | 6 | ......... | 12-Swg. | ¼ | ........... |
| "Blue Ribbon" | " " " | Dolly | (W) | 6 | ......... | 11-Swg. | ¼ | ........... |
| "Haag Twin" | " " " | Dolly (TT) | (W) | 12 | ......... | 11-Swg. | ¼ | ........... |
| "Cleveland" | Hendrickson Machine Co., Cl veland, Ohio | Oscil. Cyl. | (C) | 8 | 24x26 | 12-Swg. | ¼ | Domes. El. |
| ............... | Hirschey Co., Duluth, Minn. | Dolly | (W) | ..... | 27x27 | 12-Swg. | ¼ | Gen. Elec. |
| "Trojan" | Hogan-Spencer-Whitley Co., Erie, Penna. | Rvrs. Cyl. | (GS) & (C) | 8 | 24x32 | 12-Swg. | ¼ | Sunlight El. |
| "Trojan" | " " " | Ryrs. Cyl. | (GS) & (C) | 12 | 24x39 | 12-Swg. | ¼ | Sunlight El. |
| "Worthmore" | Holland Mfg. Co., Holland, Mich. | .......... | (AI) | 8 | 23x26 | 12-Swg. | .... | ........... |
| "Worthmore" | " " " | Cylinder | (AI) | 8 | 23x26 | 12-Swg. | .... | ........... |
| "Modern Home" | Home Devices Corp., New York, N. Y. | Rot. Rvrs. Cylinder | ....... | 6 | 22x24 | 12-Stat. | ⅛ | Gen. Elec. |
| "Horton" | Horton Mfg. Co., Ft. Wayne, Ind. | Dolly | (W) | 6 | ......... | 10-Swg. | ⅛ | Gen. Elec. |
| "Hugro Airplane" | Hugro Mfg. Co., Warsaw, Ind. | Oscil. Tub. | (C) | 8 | 37x33 | 12-Swg. | ¼ | ........... |
| "Thor 25" | Hurley Mach. Co., Chicago, Ill. | Rev. Revs. Cylinder | (GS) | 6 | 25x33 | 11-Swg. | ⅙ | Gen. Elec. Westg. |
| "Thor 25" | " " " | Rev. Rvrs. Cylinder | (C) | 6 | 25x33 | 11-Swg. | ⅙ | Gen. Elec. or Westg. |
| "Thor 32" | " " " | Rev. Rvrs. Cylinder | (GS) | 9 | 25x35 | 11-Swg. | ⅙ | Gen. Elec. or Westg. |
| "Thor 32" | " " " | Rev. Rvrs. Cylinder | (C) | 9 | 25x35 | 11-Swg. | ⅙ | Gen. Elec. or Westg. |
| "Thor 27" | " " " | Rev. Rvrs. Cylinder | (GS) | 9 | 26x36 | 12-Stat. | ¼ | Gen. Elec. or Westg. |
| "Thor 27" | " " " | R v. Rvrs. Cylinder | (C) | 9 | 26x36 | 12-Stat. | ¼ | Gen. Elec. or Westg. |
| "Thor 28" | " " " | Rev. Rvrs. Cylinder | (GS) | 12 | 26x39 | 14-Stat. | ¼ | Gen. Elec. or Westg. |
| "Thor 28" | " " " | Rev. Rvrs. Cylinder | (C) | 12 | 26x39 | 14-Stat. | ¼ | Gen. Elec. or Westg. |

ABBREVIATIONS—(A)—Aluminum. (AI)—Armco Iron. (C)—Copper. (GI)—Galvanized Iron. (*)—Portable Washer used with Stationary Tubs. (**)—Also bench for additional tubs. (***)Robbins & Myer and General Electric Motors 60% of Product. (GS)—Galvanized Steel. (M)—Metal. (R)—Reversible. (SBT)—Steam Boiler Type. (TT)—Twin Tubs. (VE)—Vitreous Enamel. (W)—Wood. (Z)—Zinc. (†)—Using two domestic motors, one for centrifugal pump and one for wringer. (‡)—Twin Tubs, Machine in each.

## CLOTHES WASHING MACHINES (Continued)

| Trade Name | Name and Address of Manufacturer | Operating Principle | Material of Tub | Capacity Sheets | Dimensions (Inches) | Length Wringer Rolls (Inches) and Type | Motor H. P. | Motor Maker |
|---|---|---|---|---|---|---|---|---|
| ................ | James Wash. Mch. Corp., Detroit, Mich............ | Rotat. Cyl. | (GS) | 8 | ......... | 12-Swg. | ... | ............ |
| "Johnson" | Johnson Elec. Washer Co., Oakland, Calif........... | Dolly (SBT) | (C) | 6 | 24x26 | 11-Stat. | ⅙ | Westg. |
| "Judd" | Judd Laundry Mch Co., Chicago, Ill.............. | Oscil. Tub | (C) | 9 | 26x40 | 12-Stat. | ¼ | Century anp Gen. Elec. |
| "Judd" | " " " | Oscil. Tub | (C) | 12 | 26x40 | 12-Stat. | ¼ | Century and Gen. Elec. |
| ................ | King Elec. Wash. Mch. Co., Baltimore, Md........... | Rotat. Tub | (C) | 12 | 27x30 | 12-Swg. | ¼ | Westg. |
| ................ | King Washing Mch. Co., Wolcott, Ind............. | Dolly | (W) | 6 | 22x24 | 11-Swg. | ⅙ | Marathon Elec. |
| ................ | Klymax Mfg. Co., Chicago, Ill. | Vac. Cup | (C) | 6 | 37x28 | ......... | ⅓ | ............ |
| "Queen" | Knoll Mfg. Co., Reading, Pa. | Dolly (**) | (W) | 8 | 26x42 | 11-Swg. | ⅙ | Emer. Elec. |
| "Universal" | Landers, Frary & Clark, New | Oscil. Cyl. | (GS) | 6 | 29½x27⅛ | 12-Swg. | ⅙ | ............ |
| "Universal" | Britain, Conn............ | Comb. Osl. and Rvol. | (C) | 6 | 29½x27⅛ | 12-Swg. | ⅙ | ............ |
| "Laun-Dry-Ette" | Laundryette Mfg. Co., Cleveland, Ohio.......... | Vac. Cup | (C) | 6 | 26½x26½ | Cent'f'gl. Drier | ⅙ | Domes. El. |
| "Little Giant" | Little Giant Wash. Mch. Co., Chicago, Ill.............. | Oscillating | (C) | 3 | 19x22½ | None | ⅒ | Gen. Elec. |
| "Locomotive" | Locomotive Elec. Wash. Mch. Co., Belleville, Ill........ | Oscillating | (C) | 8 | 16x48 | 12-Swg. | ¼ | Rob. & Myrs. |
| ................ | Lombard-White Co., Worcester, Mass............... | Hydraulic | (VE) | 8 lbs. | 22x22 | 12-Swg. | ⅙ | ............ |
| "Almetal" | Manufacturers Distrib. Co., St. Louis, Mo........... | Vac. Cup | (C) | 6 | 22x44 | 11-Swg. | ⅙ | Rob. & Myrs. |
| ................ | Marlow Mfg. Co., Cleveland, Ohio.................... | Revlv. Cyl. | (VE) | 12 | 23x54 | Cent'f'gl Drier | ⅓ | Domes. El. |
| "Maytag" | Maytag Co., Newton, Iowa.. | Dolly | (W) | 6 | 23x30 | 10-Swg. | ¼ | Gen. Elec. |
| "May ag" | " " " | Rotat. Cyl. | (A) | 12 | 22x23 | 12-Swg. | ¼ | Gen. Elec. |
| "Maytag" | " " " | Agitator | (A) | 8 | 22x23 | 12-Swg. | ¼ | Gen. Elec. |
| "Meadows" | Meadows Mfg. Co., Bloom- | Dolly | (W) | 6 | ......... | 11-Swg. | ¼ | Standard |
| "Meadowlark" | ington, Ill............... | Cylinder | (W) or (M) | 6–8 | ......... | 11-Swg. | ¼ | Standard |
| "Memac" | Medina Mfg. Co., Medina, O. | Oscil. Tub | (C) | 10 | 29x30 | 12-Swg. | ¼ | Domes. El. |
| "Electric Lady" | Michigan Wash. Mch. Co., Muskegon, Mich......... | Oscil. Cyl. | (C) | 12 | ......... | Swg. | ⅙ | ............ |
| "Michigan Electric" | " " " | Dolly | (W) | ..... | ......... | Swg. | ... | ............ |
| "Home Model" | Miller Mfg. Co., Meyersdale, Pa.................... | Dolly | (W) | 6 | 12x24 | 11-Swg. | ⅙ | Rob. & Myrs. |
| "Kill Kare" | Minier Mfg. Co., Minier, Ill. | Dolly | (W) | 6 | 28x28 | 10-Swg . | ⅙ | Tideman El. |
| "2 in 1" | " " " | Dolly | (W) | 6 | 48x28 | 10-Swg. | ⅙ | Tideman El. |
| "2 in 1" | " " " | Dolly | (W) | 7 | 48x28 | 12-Swg. | ¼ | Tideman El. |
| "Mola" | Modern Laundry Mch. Co., | Rotat. Cyl. | (GS) | 8 | ......... | 12-Swg. | ⅜ | Any |
| ' Mola" | Kan as City, Mo......... | Rotat. Cyl. | (C) | 8 | ......... | 12-Swg. | ¼ | Any |
| "Happy Day" | Natl. Sewing Mch. Co., Belvidere, Ill............... | Dolly | (W) (C) (GS) | 6 | 21x24 | 12-Swg. | ⅙ | Reynolds El. |
| "Niagara" | Niagara Appliance Co., Chicago, Ill................ | Oscil. Cyl. | (C) | 8 | 17x22 | 12-Swg. | ¼ | Westg. |
| "Cataract" | Nineteen Hundred Washer | Oscil. Tub | (C) | 8 | 28x35 | 12-Swg. | ⅙ | Gen. Elec. |
| "Cataract" | Co., Binghampton, N. Y. | Oscil. Tub | (C) | 12 | 28x39 | 12-Swg. | ¼ | Gen. Elec. |
| "1900 Agitator" | " " " | Dolly | (W) & (C) | 5 | ......... | 11-Swg. | ⅙ | ............ |
| "One Minute" | One Minute Mfg. Co., New- | Dolly (**) | (W) | 6 | 27x34 | 11-Swg. | ¼ | Domes. El. |
| "One Minute" | ton, Iowa.............. | Cylinder | (C) | 6 | 27x34 | 11-Swg. | ¼ | Domes. El. |
| "Overton" | Overton Mfg. Co., Waterloo, Iowa.................... | Rocking | (GS) | 5 | 26x26 | Cent'f'gl Drier. | ¼ | Any |
| 'Gainaday" | Pittsburgh Gage & Supply | Rotat. Cyl. | (GS) | 8 | 26x32 | 12-Swg | ¼ | Westg. |
| "Gainaday" | Co., Pittsburgh, Pa........ | Rotat. Cyl. | (C) | 8 | 26x32 | 12-Swg. | ¼ | Westg. |
| "Berkshire" | Pittsfield Mch. & Tool Co., | Rotat. Cyl. | (GS) | 6 | 22x22 | 11-Swg. | ⅙ | Gen. Elec. |
| "Berkshire" | Pittsfield, Mass.......... | Rotat. Cyl. | (C) | 6 | 22x22 | 11-Swg. | ⅙ | Gen. Elec. |
| "Streator" | Wells H. Press Co., Streator, | Dolly (**) | (W) | ..... | 26x32 | Swg. | ⅙ | Gen. Elec. |
| "Clover Leaf" | Ill....................... | Oscillating | (C) | ..... | 27x29 | Swg. | ⅙ | Gen. Elec. |
| "Daylight" | Puffer-Hubbard Mfg. Co. Minneapolis, Minn....... | Vacuum Cup (**) | (W) | 5 | 22x23 | 12-Swg. | ¼ | Emer. Elec. |
| "Richmond" | Richmond Cedar Wks., Richmond, Va............... | Dolly | (W) | 6 | 22¾x24¾ | 12-Swg. | ⅙ | Emer. Elec. |
| "Rochester Rotary" | Rochester Rotary Washer Co., Rochester, N. Y..... | Ro at. Cyl. | (GS) | 6 | 22x25 | 11-Stat. | ¼ | Rob. & Myrs. |
| "Rochester Rotary" | " " " | Rotat. Cyl. | (GS) | 10 | 22x26 | 11-S at. | ¼ | Rob. & Myrs. |
| "Rochester Rotary" | " " " | Rotat. Cyl. | (C) | 15 | 26x30 | 11-Stat. | ¼ | Rob. & Myrs. |
| "Highlander" | Rochester Wsh. Mach. Corp., | Rotat. Cyl. | (GS) | 8 | 23¼x24¼ | 11-Swg. | ¼ | Rob. & Myrs. |
| "Highlander" | Rochester, N. Y.......... | Rotat. Cyl. | (C) | 8 | 23¼x24¼ | 11-Swg. | ¼ | Rob. & Myrs' |
| "Rue" | Rue Nelson Mfg. Co., Amboy | ,Vac. Cup | (GS) | 8 | 18x30 | 11-Swg. | ¼ | Gen. Elec. |
| ................ | Minn.................. | Vac. Cup | (C) | 8 | 18x30 | 11-Swg. | ¼ | Gen. Elec. |
| "Sandusky" | Sandusky Washer Co., Sandusky, Ohio............. | Dolly | (W) | 6 | 24x27 | 11-Swg. | ¼ | Domes. El. |
| ................ | Sieben Mfg. Co., Kansas City, | Vac. Cup | (GS) | 15 | 30x30 | 12-Swg. | ¼ | Emer. Elec. |
| ................ | Mo.................... | Vac. Cup | (C) | ..... | 30x30 | 12-Swg. | ¼ | ............ |
| "Gold Seal" | Philip Smith Mfg. Co., Sidney, Ohio..............O | scillating | (C) | 8 | 27x29 | 12-Swg, | ¼ | Gen. Elec. |
| "Empire" | Standard Mfg. Co., St. Louis, Mo.................... | Oscil. Cyl. | (GS) | 6 | 23x38 | 12-Swg. | ¼ | Rob. & Myrs. |
| "Thermo" | Standard Wash. Mch. Co., Chicago, Ill.............. | Vac. Cup | (C) | 9 | 26x28 | 12-Swg. | ¼ | Gen. Elec. |
| ,'Silver Star" | Star Wash. Mch. Mfg. Co., | Rotat. Cyl. | (GS) | 6 | 24x32 | 11-Swg. | ¼ | Rob. & Myrs. |
| ................ | Chicago, Ill............. | Rotat. Cyl. | (C) | 6 | 24x32 | 11-Swg. | ¼ | Rob. & Myrs. |

## CLOTHES WASHING MACHINES (Continued)

| Trade Name | Name and Address of Manufacturer | Operating Principle | Material of Tub | Capacity Sheets | Dimensions (Inches) | Length Wringer Rolls (Inches) and Type | Motor H. P. | Motor Maker |
|---|---|---|---|---|---|---|---|---|
| "Surf" | Sunbeam Domes. Appl. Co., Evansville, Ind. | Oscillating | (C) | 8 | 25x30 | 12-Swg. | 1/6 | Westg. |
| "Sunnysuds" | Sunny Line Appliance Inc., Detroit, Mich. | Oscil. Cyl. | (C) | 6 | ......... | 11-Swg. | 1/4 | ............ |
| "Sterling" | Superior Mch. Co., De Kalb, | Oscil. Tub | (W) | 8 | 24x43 | 12-Swg. | 1/4 | Rob. & Myrs. |
| "Sterling" | Ill. | Oscil. Tub | (W) | 8 | 24x27 | 12-Swg. | 1/4 | Rob. & Myrs. |
| "Success" | " " " | Dolly (**) | (W) | 8 | 24x43 | 12-Swg. | 1/4 | Rob. & Myrs. |
| "Success" | " " " | Dolly | (W) | 8 | 24x27 | 1-2Swg. | 1/4 | Rob. & Nyrss |
| "Success" | " " " | Dolly (**) | (W) | 16 | 24x43 | 12-Swg. | 1/4 | Rob. & Myr. |
| "Simplex" | " " " | Dolly | (W) | 8 | 21x24 | 12-Swg. | 1/4 | Rob. & Myrs. |
| "Submarine" | " " " | Dolly (**) | (W) | 8 | 24x43 | 12-Swg. | 1/4 | Rob. & Myrs. |
| "Submarine" | " " " | Dolly | (W) | 8 | 24x27 | 12-Swg. | 1/4 | Rob. & Myrs. |
| "Submarine" | " " " | Dolly (**) | (W) | 16 | 24x43 | 12-Swg. | 1/4 | Rob. & Myrs. |
| "Submarine" | " " " | Dolly | (W) | 8 | 21x24 | 12-Swg. | 1/4 | Rob. & Myrs. |
| "Superior" | " " " | Oscillating | (C) | 8 | ....... | 12-Swg. | 1/4 | Rob. & Myrs. |
| "Easy" | Syracuse Wash. Mach. Corp., | Vac. Cup | (Z) | 10 | 24x18 | 12-Swg. | 1/8 | Gen. Elec. |
| ............... | Syracuse, N. Y. | Vac. Cup | (C) | 10 | 24x18 | 12-Swg. | 1/8 | Gen. Elec. |
| ............... | " " " | Vac. Cup | (GS) | 10 | 24x18 | 12-Swg. | 1/8 | Gen. Elec. |
| "Up-2-Date" | Thistle Mfg. Co., Chicago, Ill. | Ilolly | (C), (Z) (W) | 6 | 21 Diam. | 11-Swg. | 1/8 | Reynolds El |
| "Tri-Plex" | Tri-Plex Vacuum Elec. Washer Co., Pekin, Ill. | Vac. Cup | (W) | 6 | 16x26 | 11-Swg. | 1/6 | Any |
| "United" | United Engine Co., Lansing, | Dolly | (W) | 6 | 27x38 | 11-Swg. | 1/4 | Any |
| "United" | Mich. | Dolly (TT) | (W) | 12 | 27x65 | 11-Swg. | 1/4 | Any |
| "United" | " " " | Oscil. Tub | (GS) | 12 | 27x65 | 12-Swg. | 1/4 | Gen. Elec. |
| "United" | " " " | Oscil. Tub | (C) | 12 | 27x65 | 12-Swg. | 1/4 | Gen. Elec. |
| "Victoria" | Universal Utilities Corp., Alpena, Mich. | Rotat. Cyl. | (AI) | 6 | 14x2½ | None | .... | Domes. El. |
| "Upton" | Upton Machine Co., St. Joseph, Mich. | Oscil. Cyl. | (W) | 6 | 26x26 | 12-Swg. | 1/4 | Gen. El. & Westg. |
| "National" | Vacuum Washer Co., Ripon, Wis. | Vac. Cup | (C) | 4 | 23 Diam. | 11-Swg. | 1/6 | Emerson |
| "Very Best Made" | V. B. M. Company, Chicago, Ill. | Rotat. Cyl. | (GS) | 6 to 8 | 23x24 | 11-Swg. | 1/6 | Westg. |
| "Very Best Made" | " " " | Rotat. Cyl | (C) | 6 to 8 | 23x24 | 11-Swg. | 1/6 | Westg. |
| "Wonder" | Victor Mfg. Co., Leavenworth, Kan. | Vac. Cup | (W) (C) (GS) & (AI) | 5 | 21x22 | Stat. | 1/4 | Rob. & Myrs. |
| ............... | Voss Bros. Mfg. Co., Daven- | Dolly (**) | (AI) (W) | 6 | 28x30 | Swg. | 1/4 | Gen. Elec. |
| ............... | port, Iowa. | V. Cup (**) | (W) | 6 | 28x30 | Swg. | 1/4 | Gen. Elec. |
| ............... | " " " | Dolly | (W) | 6 | 39x66 | Swg. | 1/4 | Gen. Elec. |
| ............... | " " " | Vac. Cup | (W) | 6 | 39x66 | Swg. | 1/4 | Gen. Elec. |
| ............... | " " " | Dolly | (W) | 6 | 39x87 | Swg. | 1/4 | Gen. Elec. |
| ............... | " " " | Vac. Cup | (W) | 6 | 39x87 | Swg. | 1/4 | Gen. Elec. |
| ............... | " " " | Oscil. Tub | (C) | 6 | 28x30 | Swg. | 1/4 | Gen. Elec. |
| "Bauer" | Vulcan Mfg. Co., Kansas City, Mo. | Rotat. Cyl. | (GS) or (C) | 8 | 24x25 | 12-Swg. | 1/6 | Rob. & Myrs. |
| "Washkosh" | Wash Kosh Mfg. Co., Oshkosh, Wis. | Vac. Cup | (C) | 7 | 26½x26½ | 12-Swg. | 1/4 | Gen. Elec. |
| ............... | Wayne Mfg. Co., St. Louis, | Dolly | (W) | 4 | 28x28 | 10-Swg. | 1/4 | Rob. & Myrs. |
| ............... | Mo. | Vac. Cup | (W) | 4 | 28x28 | 10-Swg. | 1/4 | Rob. & Myrs. |
| ............... | " " " | Dolly | (W) | 4 | 47x47 | 11-Swg. | 1/4 | Rob. & Myrs. |
| ............... | " " " | Vac. Cup | (W) | 4 | 47x47 | 11-Swg. | 1/4 | Rob. & Myrs. |
| ............... | " " " | Rocking | (C) | 6 | 38x24 | 11-Swg. | 1/4 | Rob. & Myrs. |
| "Supreme" | Wenzelmann Mfg. Co., Galesburg, Ill. | Oscillating | (C) | 6 to 10 | 28x44 | Cent'f'gl Wringer | 1/6 | ............ |
| "Western Electric" | Western Electric Co., New York, N. Y. | Rotat. Cyl. | (GS) | 6 | 25x35 | 11-Swg. | 1/6 | West. Elec. |
| "Western Electric" | " " " | Rotat. Cyl. | (C) | 6 | 25x35 | 11-Swg. | 1/6 | West. Elec. |
| "White Lily" | White Lily Mfg. Co., Daven- | Dolly | (W) | 5 | 27x27 | 10-Stat. | 1/6 | Emer. Elec. |
| "White Way" | port, Iowa. | Dolly | (W) | 5 | 27x27 | 10-Stat. | 1/6 | Emer. Elec. |
| "White Platform" | " " " | Dolly | (W) | 5 | 31x100 | 12-Stat. | 1/4 | Emer. Elec. |
| "White Twin" | " " " | Dolly | (W) | 10 | 31x54 | 12-Swg. | 1/4 | Emer. Elec. |
| "De Luxe" | " " " | Rotat. Cyl. | (GS) | 6 | 26x28 | 12-Stat. | 1/4 | Emer. Elec. |
| "De Luxe" | " " " | Rotat. Cyl. | (C) | 6 | 26x28 | 12-Stat. | 1/4 | Emer. Elec. |
| "De Luxe Cabinet" | " " " | Rotat. Cyl. | (GS) | 8 | 27x29 | 12-Swg. | 1/4 | Emer. Elec. |
| "De Luxe Cabinet" | " " " | Rotat. Cyl. | (C) | 8 | 27x29 | 12-Swg. | 1/4 | Emer. Elec. |
| "California Maid" | H. E. Williamson, San Francisco, Cal. | Rotat. Cyl. | (GS) | 7 to 8 | 19x33 | 11-Swg. | 1/6 | Invincible |
| ............... | Win-Her Washer Co., Des Moines, Iowa | Rotat. Cyl. | (GS) | 6 | 24x24 | 12-Swg. | 1/4 | Century Elec. |
| "Rust Proof" | Woodrow Mfg. Co., Newton, | Dolly (**) | (W) | 6 | ......... | 12-Swg. | 1/6 | Emer. Elec. |
| "Rust Proof" | Iowa. | Dolly (**) | (C) | 6 | ......... | 12-Swg. | 1/6 | Emer. Elec. |
| "Rust Proof" | " " " | (†) | (W) | 12 | ......... | 12-Swg. | 1/6 | Emer. Elec. |
| "Rust Proof" | " " " | (††) | (C) | 12 | ......... | 12-Swg. | 1/6 | Emer. Elec. |
| ............... | Worthmore Mfg. Co., Kalamazoo, Mich. | Oscil. Cyl. | (GS) | 6 | 22x27 | 10-Swg. | 1/4 | Gen. Elec. |

## DISH WASHING MACHINES

| Trade Name | Name and Address of Manufacturer | Operating Principle | No. of Tanks | Material of Tanks | Capacity Dishes per Hour | Dimensions (Inches) | Motor H. P. | Motor Maker |
|---|---|---|---|---|---|---|---|---|
| .......... | G. S. Blakeslee & Co. | Centrifugal Agitation | 1 | (GI) | Domes. Size | 20x24 | 1/4 | .......... |
| .......... | " " " " | Centrifugal Agitation | 1 | (C) | Domes. Size | 22x36 | 1/4 | .......... |
| "Conover" | Conover Mfg. Co., Chicago, Ill. | Centrifugal Agitator | 1 | (C) | Domes. Size | 35x24 | 1/6 | Robb. & Myers |
| "Shank" | Cyrus-Shank Co., Chicago, Ill. | Centrifugal Agitator | 1 | (C) | Domes. Size | 14x26 | 1/12 | .......... |
| "PDQ" | Dow Mfg. Co., Braintree, Mass. .................. | Spray | 1 | (C) (P) | Domes. Size | 22x36 | 1/4 | General Elec. |
| "Star" | Fitzgerald Mfg. Co., Torrington, Conn. .............. | ....... | .. | (AI) | Domes. Size | 32x24x35 | 1/4 | Domes. Elec. |
| .......... | Happy Home Co., Inc., Detroit, Mich. .............. | Centrifugal Agitation | 1 | (GI) | Domes. Size | 22x36 | 1/4 | .......... |
| "Holiday" | Hood Sales Corp., New York, N. Y. .................... | Spray | 1 | (N) | Domes. Size | 23½ diam. | 1/6 | General Elec. |
| .......... | Jewel Elec. & Mfg. Co., Chicago, Ill. ................. | Centrifugal Agitation | 1 | (GI) | Domes. Size | 36x21–20 | 1/6 | Own |
| "Quaker" | Quaker Dishwasher Sales Co., Philadelphia, Pa. .......... | Spray | 1 | (C) | Domes. Size | 20x20 | 1/15 | Westinghouse |
| "E-Z-Way" | Redmon Edgar & Redmon Cedar Rapids, Iowa ...... | Centrifugal Agitation | 1 | (GI) | Domes. Size | ...... | 1/4 | Westinghouse |
| .......... | Walker Bros. Co., Syracuse, N. Y. .................... | Centrifugal Agitation | 1 | (T) | Domes. Size | 21½x32½ | 1/4 | General Elec. |
| .......... | Walker Bros. Co., Syracuse, N. Y. .................... | Centrifugal Agitation | 1 | (C) | Domes. Size | 21½x32½ | 1/4 | .......... |
| .......... | Western Elec. Co., New York, N. Y. .................... | Spray | 1 | (C) | Domes. Size | 47x27x31½ | 1/6 | .......... |
| .......... | Whirlpool Mfg. Co., Philadelphia, Pa. .............. | ...... | 1 | (C) | Domes. Size | 18 diam. | 1/4 | General Elec. |

ABBREVIATIONS—(AI) Armco Iron; (C) Copper; (GI) Galvanized Iron; (N) Nickel; (P) Porcelain Enamel (T) Tin.

## ELECTRIC IRONS

| Trade Name | Name and Address of Manufacturer | Type | Weight (Lbs.) | Maximum Wattage | Heats |
|---|---|---|---|---|---|
| "American Beauty" | American Elec. Heater Co., Detroit, Mich... | Domestic | 6½ | 525 | 1 |
| "Little Beauty" | " " " " | Domestic | 3 | 350 | 1 |
| "Elite" | Bersted Mfg. Co., Chicago, Ill. ........ | ........ | 6½ | 550 | 1 |
| "Premier" | Geo. Borgfeldt & Co., New York, N. Y ..... | Domestic | 6 | 450 | 1 |
| "Liberty" | L. S. Brach Mfg. Co., Newark, N. J. ........ | ........ | 6 | 660 | 1 |
| "La Belle" | W. T. Burt Co., New Cumberland, W. Va. .... | ........ | 6 | 550 | 1 |
| "Sheldon" | Casey-Sheldon-Foster, Boston, Mass. ........ | ........ | 6 | 550 | 1 |
| "Duo Point" | Central Flatiron Mfg. Co., Johnson City, N.Y. | ........ | 6 (SS) | 550 | 1 |
| "Domestic" | Chicago Flexible Shaft Co., Chicago, Ill.... | Domestic | 6 | 550 | 1 |
| "Princess" | " " " " | Domestic | 6 | 550 | 1 |
| "Sunbeam" | " " " " | Domestic | 6 | 550 | 1 |
| "Favorite" | The Dover Mfg. Co., Dover, Ohio.......... | Domestic | 6 | 550 | 1 |
| "Domanco Traveler" | " " " | Domestic | 3½ | 275 | 1 |
| "Domanco" | " " " | Domestic | 6 | 550 | 1 |
| "Dover Tourist" | " " " | Domestic | 3½ | 275 | 1 |
| "Dover 32" | " " " | Domestic | 6 | 600 | 1 |
| "Dover" | " " " | Domestic | 6 | 550 | 1 |
| "Hotpoint" | Edison Elec. Appliance Co., Inc., Chicago, Ill. | Traveling | 3 | 550 | 1 |
| "Hotpoint" | " " " " " | Domestic | 6 (AS) | 550 | 1 |
| "Hotpoint" | " " " " " | Domestic | 6 | 330 | 1 |
| "Hotpoint" | " " " " " | Domestic | 5 | 575 | 1 |
| "Hotpoint" | " " " " " | Traveling Set | 3 | 700 | 1 |
| "Franklin" | Elec. Development & Mach. Co., Phila., Pa. | Domestic | 6 | 575 | 1 |
| "Empire" | Empire Transformer Co., Chicago, Ill....... | Domestic | 6 | 550 | 1 |
| "Globe" | Globe Stove & Range Co., Kokomo, Ind..... | Domestic | 6¼ | 625 | 1 |
| "Service" | Home Service Elec. Wks., New Haven, Conn. | Domestic | 6 | 525 | 1 |
| "Baby" | International Elec. Co., Indianapolis, Ind. | Domestic | 1½ | 176 | 1 |
| "Universal" | Landers, Frary & Clark, New Britain, Conn. | Domestic | 3 (SS) | 350 | 1 |
| "Universal" | " " " " " | Domestic | 5 (SS) | 580 | 1 |
| "Universal" | " " " " " | Domestic | 6 (AS) | 580 | 1 |
| "Universal" | " " " " " | Domestic | 6 (SS) | 580 | 1 |
| "Universal" | " " " " " | Traveling Set | 3 (SS) | 350 | 1 |
| "Ideal Heat" | Loetscher-Ryan Mfg. Co., Rock Island, Ill. | Tourist | 3 | 325 | 1 |
| "Ideal Heat" | " " " " " | Tourist | 4 | 350 | 1 |
| "Ideal Heat" | " " " " " | Domestic | 5 & 6 | 525 | 1 |
| "Ideal Heat" | " " " " " | Domestic | 7 & 8 | 525 | 1 |
| " 20 Century" | A. G. Lucas Co., Chicago, Ill............... | Domestic | 6½ | 550 | 1 |
| "Colored Prince" | " " " | Domestic | 6 | 550 | 1 |
| "Double Duty" | " " " | Domestic | 6½ | 560 | 1 |
| "Marvelous" | " " " | Domestic | 6 | 550 | 1 |
| "Travelers' Delight" | " " " | Traveling | 3 | 350 | 1 |
| "Mesco" | Manhattan Elec. Supply Co., New York, N. Y. | Domestic | 3 | 450 | 1 |
| "Mesco" | " " " " " | Domestic | 5 & 6 | 550 | 1 |
| "Manning, Bowman Quality" | Manning, Bowman & Co., Meriden, Conn. | Domestic | 6 | 550 | 1 |
| "Manning, Bowman Quality" | " " " " " | Traveling | 3 | 330 | 1 |
| "White Cross" | Nat'l Stamping & Elec. Wks., Chicago, Ill.. | Domestic | 6½ | 525 | 1 |
| "Ideal" | Pelouze Mfg. Co., Chicago, Ill ............ | Domestic | 6 | 250 | 1 |
| "Standard" | " " " | Domestic | 4 | 500 | 1 |
| "Standard" | " " " | Domestic | 6½ | ... | .. |
| "Standard" | " " " | Traveling | 4 | 500 | 1 |
| "Hedlite" | Pittsburgh Elec. Specialties Co., New York, N. Y. ........ | Domestic | 6 | 550 | 1 |
| "Victory" | | Domestic | 6 | 550 | 1 |
| "Redtop" | Red Top Electric Co., New York, N. Y..... | Domestic | 6½ | 550 | 1 |
| "Redtop" | " " " " " | Domestic | 6½ | 550 | 3 |
| "Regulator" | Reimers Elec. Appliance Co., New York, N. Y. | Domestic | 6 (R) | 550 | 4 |
| "Royal Rochester" | Rochester Stamping Co., Rochester, N. Y.. | Domestic | 3 | 600 | 5 |
| "Royal Rochester" | " " " " " | Domestic | 6 | 500 | 5 |
| .................... | Rutenber Electric Co., Marion, Ind......... | Domestic | 6 | 275 | 1 |
| "World's Best" | Security Elec. Mfg. Co., Chicago, Ill........ | Domestic | 6 | 500 | 1 |
| "Challenge" | " " " | Domestic | 5½ | 500 | 1 |
| "Security" | " " " | Domestic | 6 | 500 | 1 |
| "Milady's" | " " " | Domestic | 6 | 500 | 1 |
| "Perfection" | " " " | Domestic | 6½ | 500 | 1 |
| "Empress" | " " " | Domestic | 6 | 500 | 1 |
| "1914" | Simplex Elec. Heating Co., Cambridge, 39, Mass. ........ | Travelers | 3½ | 300 | 1 |
| "1915" | | Domestic | 6 | 570 | 1 |
| "Stahot" | Steatite Products Co., Inc., New York, N. Y. | Domestic | 6 | 600 | 1 |
| "Trip-L-Heat" | Waage Electric Co., Chicago, Ill............ | Domestic | 4½ | 550 | 3 |
| "Trip-L-Heat" | " " " | Domestic | 6¼ | 600 | 3 |
| "Single Heat" | " " " | Domestic | 4½ | 450 | 1 |
| "Single Heat" | " " " | Domestic | 6¼ | 550 | 1 |
| "Four Heat" | " " " | Domestic | 4½ | 550 | 4 |
| "Four Heat" | " " " | Domestic | 6¼ | 650 | 4 |
| "Four Heat" | " " " | Domestic | 8 | 700 | 4 |
| .................... | " " " | Travelers | 3 | 350 | 1 |
| .................... | Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa. ........ | Traveling | 3 | 250 | 1 |
| .................... | | Domestic | 6 | 550 | 1 |
| .................... | " " " " " | Domestic | 6½ | 550 | 1 |

ABBREVIATIONS—(AS) Attached Stand. (R) Regulating. (SS) Separate Stand.

## ELECTRIC RANGES

| Trade Name | Name and Address of Manufacturer | RANGE | | | OVEN | | |
|---|---|---|---|---|---|---|---|
| | | Dimension (Inches) | Number and Type of Burner | Maximum Wattage Demand of All Burners. | No. and Location of Burners | Maximum Wattage Demand of All Burners | Dimension (Inches) |
| ........ | Amer. Elec. Heater | | | | | | |
| | Co., Detroit, Mich. | 22x16x31 | 2-Enclosed (*) | 2000 | ............ | .... | 18x10½x5½ |
| "Hughes" | Edison Elec. Appli- | 26½x16¼x29 | 2-Open Radiant (**) | 2200 | ............ | .... | .......... |
| "Hughes" | ance Co., Chicago, | 33x16½x22 | 2-Open Radinat | 1980 | 1 (HO)-1 (LO) | 1320 | 10x10x12 |
| "Hughes" | Ill............... | 18¼x26½x58 | 2-Open Radiant | 2380 | 1 (HO)-1 (LO) | 1760 | 18x12x12 |
| "Hotpoint" | " " | 33x17x54 | 2-Open Radiant | 2300 | 1 (HO)-1 (LO) | 2300 | 16½x14x11 |
| ........ | Estate Stove Co., | 33x29x16 | 3-Enclosed | 2400 | 1 (HO)-1 (LO) | 3400 | 18x12x12 |
| ........ | Hamilton, Ohio... | 49x23½x18 | 3-Enclosed | 2420 | 1 (HO)-1 (L) | 3500 | 18x12x10 |
| ........ | G. D. Roper Corp., | | | | | | |
| ........ | Rockford, Ill...... | .......... | ................ | 1000 | 3 (HO) | 1650 | 15x16x12 |

ABBREVIATIONS: (HO)—High Oven (above the range top). (LO)—Low Oven (below the range top.) (*)—Furnished with or without portable oven. (**)—No oven burners, portable oven, placed on range top.

## FIRELESS COOKERS

| Trade Name | Name and Address of Manufacturer | Utensil or Type | Capacity, Weight, Size, or Dimensions | Maximum Wattage | Heats |
|---|---|---|---|---|---|
| "Allmur" | Allmur Mfg. Company, Marion, | (*) | 1 compartment, 8 qt. | 660 | 1 |
| "Allmur" | Ind...................... | .......... | 2 compartments, 8 qt. | 1,320 | 1 |
| "Allmur" | " " " | .......... | 1 compartment, 12 qt. | 660 | 1 |
| "Allmur" | " " " | .......... | 2 compartments, 12 qt. | 1,320 | 1 |
| "Kercher" | Cal-Met Mfg. Co., Oakland, Cal. | .......... | 4 compartments, 14 qt. | 660 | 1 |
| "Rapid" | Wm. Campbell Company, De- | (*) | 1 compartment, 8 qt. | 660 | 1 |
| .......... | troit, Mich.............. | .......... | 2 compartments, 8 qt. | 1,800 | 1 |
| .......... | " " " | .......... | 3 compartments, 8 qt. | 1,800 | 1 |
| .......... | The Standard Elec. Stove Co., | .......... | (‡) 13x13x20 | 660 | 2 |
| .......... | Toledo, Ohio.............. | Automatic | (‡) 13x13x20 | 660 | 2 |
| .......... | " " " | .......... | (‡) 13x25x20 | 1,320 | 2 |
| .......... | " " " | .......... | (‡) 13x25x20 | 1,320 | 2 |
| "Stero" | Sterolectric Co., Muncie, Ind... | (**)Automatic | (†) 16x18x35 | 660 | 3 |
| "Radioductor" | H. G. Weeks Mfg. Co., Hamilton, | | | | |
| | Ohio..................... | .......... | 18x24x12 | 800 | 3 |

ABBREVIATIONS: (*)—Also 2 compartments, oblong, double capacity. (**)—Equipped with hot plate. (†)—Set of Containers, ⅛ qt.; ½ qt. (‡)—Set of Containers, ⅛ qt.; ½ qt.; 2½ qt.

## IRONING MACHINES

| Trade Name. | Name and Address of Manufacturer | Dimension (In.) | Shipping Weight (Lbs.) | Length of Rolls | Heated By | Maximum Wattage | Motor | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | h.p. | Maker |
| "Simplex" | Amer. Ironing Mch. Co., | 60x50 | 330 | 37 | (E)-(G)-(GA) | .... | ⅛ | Robb. & Myers |
| "Simplex" | Chicago, Ill............ | 65x50 | 355 | 42 | (E)-(G)-(GA) | .... | ⅛ | Robb. & Myers |
| "Simplex" | " " " | 69x50 | 560 | 46 | (E)-(G)-(GA) | .... | ⅛ | Robb. & Myers |
| "Simplex" | " " " | 84x108 | 650 | 48 | (E)-(G)-(GA) | .... | ¼ | Robb. & Myers |
| "Simplex" | " " " | 92x108 | 670 | 56 | (E)-(G)-(GA) | .... | ¼ | Robb. & Myers |
| .......... | Apex Appliance Co., Chi- | | | | | | | |
| | cago, Ill............... | 26x60 | 400 | 48 | (E)-(G)-(GA) | .... | ¼ | Robb. & Myers |
| "Rotarex" | Apex Elec. Distrib. Co., | 46x22 | 200 | 32 | (G) | .... | ⅙ | Domes. Elec. |
| "Rotarex" | Chicago, Ill............ | 46x22 | 200 | 32 | (E) | 2000 | ⅙ | Domes. Elec. |
| "Rotarex" | " " " | 56x22 | 260 | 42 | (G) | .... | ⅙ | Domes. Elec. |
| "Rotarex" | " " " | 56x22 | 260 | 42 | (E) | 2500 | ⅙ | Domes. Elec. |
| "Rotarex" | " " " | 60x22 | 280 | 46 | (G) | .... | ⅙ | Domes. Elec. |
| "Rotarex" | " " " | 60x22 | 280 | 46 | (E) | 3000 | ⅙ | Domes. Elec. |
| "Capitol" | Barnett Fdry. & Mch. Co., | 26x54 | 350 | 46 | (E)-(G)-(GA) | .... | ⅛ | General. Elec. |
| "Handy" | Irvington, N. J.......... | 26x54 | 350 | 46 | (E)-(G)-(GA) | .... | ⅛ | General Elec. |
| .......... | Chicago Dryer Co., Chicago, | 28x79 | 750 | 50 | (E)-(G)-(GA) | .... | ⅙ | Century Elec. |
| .......... | Ill...................... | 28x89 | 900 | 60 | (G)-(GA) | .... | ⅙ | Century Elec. |
| .......... | " " " | 28x104 | 1100 | 75 | (G)-(GA) | .... | ⅙ | Century Elec. |
| "Baby Grand" | Grand Mfg. Co., Detroit, | | | | | | | |
| | Mich.................. | 15x35 | 90 | 26 | (E)-(G) | 1000 | ⅒ | General Elec. |
| .......... | Hoe Corporation, Pough- | 59x31 | 420 | 42 | (E)-(G)-(GA) | .... | ⅒ | Emerson Elec. |
| .......... | keepsie, N. Y........... | 63x31 | 440 | 46 | (E)-(G)-(GA) | .... | ⅛ | Emerson Elec. |
| .......... | " " " | 67x31 | 460 | 50 | (E)-(G)-(GA) | .... | ⅙ | Emerson Elec. |
| .......... | " " " | 84x32 | 900 | 55 | (E)-(G)-(GA) | .... | ¼ | Emerson Elec. |
| .......... | " " " | 94x32 | 940 | 65 | (E)-(G)-(GA) | .... | ⅓ | Emerson Elec. |
| .......... | " " " | 102x32 | 980 | 75 | (E)-(G)-(GA) | .... | ⅓ | Emerson Elec. |
| .......... | Horton Mfg. Co., Ft. Wayne, | 26x58 | 350 | 42 | (E)-(G)-(GA) | .... | ⅒ | General Elec. |
| .......... | Ind..................... | 26x62 | 375 | 46 | (G)-(GA) | .... | ⅒ | General Elec. |
| .......... | " " " | 26x66 | 400 | 50 | (G)-(GA) | .... | ⅙ | General Elec. |
| "Thor" | Hurley Machine Co., Chi- | 26x54 | 480 | 44 | (E)-(G)-(GA) | .... | ⅙ | General Elec. |
| .......... | cago, Ill................ | 26x60 | 496 | 50 | (G)-(GA) | .... | ⅙ | General Elec. |
| "Multiplex" | Natl. Laundry Mchry. Co., | 36x90 | 850 | 76 | (G) | .... | ¼ | Any |
| "Multiplex" | Chicago, Ill............ | 36x99 | 1000 | 85 | (G) | .... | ¼ | Any |
| "Multiplex" | " " " | 36x103 | 1200 | 94 | (G) | .... | ¼ | Any |
| .......... | Nineteen Hundred Washer | | | | | | | |
| | Co., Binghamton, N. Y... | 27x58 | 500 | 44 | (G) | .... | ⅒ | General Elec. |

## IRONING MACHINES (Continued)

| Trade Name. | Name and Address of Manufacturer | Dimension (In.) | Shipping Weight (Lbs.) | Length of Rolls | Heated By | Maximum Wattage | Motor h.p. | Motor Maker |
|---|---|---|---|---|---|---|---|---|
| "Oasis" | Oasis Mfg. Co., Peoria, Ill.. | 28x60 | 375 | 46 | (E)-(G)-(GA) | .... | 1/4 | .......... |
| "Gainaday" | Pittsburgh Gage & Supply | 52x30 | 435 | 42 | (E)-(G)-(GA) | .... | 1/10 | .......... |
| .......... | Co., Pittsburgh, Pa........ | 56x30 | 485 | 46 | (E)-(G)-(GA) | .... | 1/10 | .......... |
| .......... | " " " | 60x30 | 525 | 47 | (E)-(G)-(GA) | .... | 1/8 | .......... |
| "Quaker Maid" | Quaker Mfg. Co., Chicago, | 27x58 | 325 | 44 | (E)-(G)-(GA) | .... | 1/6 | Westinghouse |
| "Quaker Maid" | Ill...................... | 27x62 | 350 | 48 | (E)-(G)-(GA) | .... | 1/6 | Westinghouse |
| "Utenco" | Utensils Co., Ft. Wayne, Ind.................. | 21x40 | 200 | 24 | (G) | .... | .. | General Elec. |
| .......... | Western Electric Co., New York, N. Y............. | 21x67 | 432 | 46 | (G)-(GA) | .... | 1/6 | Own |
| "Win-Her" | "Win-Her" Washer Co., Des Moines, Iowa............ | 24x64 | 375 | 42 | (E)-(GA) | .... | 1/4 | Own |
| "Cottage" | William G. Yates, Cleveland, Ohio.................. | 21 1/2x54 | ... | 46 | (G)-(GA) | .... | 1/6 | .......... |

ABBREVIATIONS: (E)—Electricity. (G)—Gas. (GA)—Gasoline.

## REFRIGERATORS AND ICE MAKING MACHINES

| Trade Name | Name and Address of Manufacturer | Ice Cap. (**) | Size of Brine Tank (Gals) | Refrigerant | Type of Condenser | Av. Temp. of Food Compartment (*) | Cu. Ft. Cap. of Food Compartment | Motor H. P. | Motor Make |
|---|---|---|---|---|---|---|---|---|---|
| "Frigidor" | Balsa Refrig. Co., New York, N. Y......... | 200 | None | Methyl Chloride | Air-Cooled | 36 | 15 | 1/4 | Century |
| "Clothel" | Closel Refrig. Co., New York, N. Y.... | 250 | None | Ethyl Chloride | Water-Cooled | 42 | 15 | 1/2 | Holtzer-Cabot |
| "Frigidaire" | Frigidaire Corp., Dayton, Ohio........... | 160 | 5 | Sulphur Dioxide | Air-Cooled | 44 | 9 | 1/4 | Holtzer-Cabot |
| "Isko" | Isko Corp.,(#) Chicago, Ill......... | 200 | 8 up. | Sulphur Dioxide | Water-Cooled | 43 | .. | 1/4 | Century |
| "Kelvinator" | Kelvinator Corp (#) Detroit, Mich....... | 150 | .. | Sulphur Dioxide | Air-Cooled | 44 | 20 | 1/4 | Century |
| "Kelvinator" | " " | 175 | .. | Sulphur Dioxide | Air-Cooled | 44 | 30 | 1/4 | Century |
| "Kelvinator" | " " | 200 | .. | Sulphur Dioxide | Air-Cooled | 44 | 40 | 1/4 | Century |
| "Radiant" | Radiant Mfg. Co., Sandusky, Ohio......... | 200 | 5 | Methyl Chloride | Water-Cooled | 44 | 10 | 1/6 | Ge7eral Elec. |
| "Refrigo" | Refrigo Co.,(#) Milwaukee, Wis..... | 100 | .. | Ammonia | Water-Cooled | 42 | 25 | 1/4 | Allis-Chambers |
| "Powrkold" | G. Spalt & Sons, Inc., Albany, N. Y........ | 200 | 10 | Ethyl Chloride | Water-Cooled | 38 | 14 | 1/4 | Century and Holtzer-Cabot |
| "Coldmaker" | Toledo Coldmaker Co., Toledo, Ohio........ | 250 | None | Ammonia | Water Cooled | 38 | 40 | 1/4 | .......... |
| "Utility" | Utility Compressor Co., Detroit, Mich....... | 150 | None | Sulphur Dioxide | Air-Cooled | 44 | 10 | 1/4 | Own |
| "Chilrite" | Winter Mach. Co., Pawtucket, R. I......... | 175 | .. | Sulphur Dioxide | Water-Cooled | 44 | .. | 1/4 | General Elec. |
| "Chilrite" | " " | 200 | .. | Sulphur Dioxide | Water-Cooled | 44 | .. | 1/4 | General Elec. |

ABBREVIATIONS: (*)—Outside temperature being 70 degrees Fahr. (**)—Equivalent to pounds of ice used in 24 hours, outside temperature being 70 degrees Fahr. (#)—Furnish only machine, to fit standard makes of Refrigerators.

## SEWING MACHINES, ELECTRIC

| Trade Name | Name and Address of Manufacturer | Type | Weight (Lbs.) | Style | Size of Head | Method of Control | Make of Control | Make of Motor |
|---|---|---|---|---|---|---|---|---|
| .......... | Davis Sewing Mach. Co., | Portable | 30 | Vibrator | 3/4 | Foot | Hamilton-Beach | Hamilton-Beach |
| .......... | Dayton, Ohio......... | Portable | 36 | Rotary | Full | Foot | Hamilton-Beach | Hamilton-Beach |
| .......... | " " " | Portable | 37 | Vibrator | Full | Foot | Hamilton-Beach | Hamilton-Beach |
| "Hotpoint" | Edison Elec. Appliance | Portable | 30 | Vibrator | 3/4 | Foot | General Elec. | General Elec. |
| "Hotpoint" | Co., Chicago, Ill...... | Portable | 36 | Vibrator | Full | Foot | General Elec. | General Elec. |
| "Hotpoint" | " " " | Portable | 36 | Rotary | Full | Foot | General Elec. | General Elec. |
| "Free | Free Sewing Mach. Co., | Portable | 30 | Rotary | Full | Foot | Cutler-Hammer | Westinghouse |
| Westinghouse" | Rockford, Ill......... | Cabinet | 88 | Vibrator | Full | Knee | Cutler-Hammer | Westinghouse |
| "Wilson" | A. G. Mason Mfg. Co., | Portable | 45 | Vibrator | Full | Foot | Hamilton-Beach | Hamilton-Beach |
| "Crown" | Cleveland, Ohio....... | Portable | 45 | Rotary | Full | Foot | Hamilton-Beach | Hamilton-Beach |
| .......... | Standard Sewing Mach. Co., New York, N. Y. | Portable Cabinet | 35 | Rotary | Full | Foot | Hamilton-Beach | Hamilton-Beach |
| .......... | Western Elec. Co., New | Portable | 32 | Vibrator | 3/4 | Foot | Western Elec. | Hamilton-Beach |
| .......... | York, N. Y........... | Portable | 35 | Rotary | Full | Foot | Western Elec. | Hamilton-Beach |
| .......... | " " " | Portable | 29 | Automatic | Full | Foot | Western Elec. | Hamilton-Beach |
| .......... | " " " | Portable | 37 | Two Spool | Full | Foot | Western Elec. | Hamilton-Beach |
| .......... | White Sewing Mch. Co., | Portable | 45 | Vibrator | Full | Foot | Hamilton-Beach | Hamilton-Beach |
| "Martha | Cleveland, Ohio....... | Portable | 45 | Rotary | Full | Foot | Hamilton-Beach | Hamilton-Beach |
| Washington" | " " " | Cabinet | 81 | Rotary | Full | Knee | Hamilton-Beach | Hamilton-Beach |
| .......... | Wilcox & Gibbs Sew. Mch. Co., New York, N. Y.. | Portable | 35 | Automatic | Full | Foot | Westinghouse | Westinghouse |

# TABLE UTENSILS

| Trade Name | Name and Address of Manufacturer | Utensil or Type | Size or Capacity Dimension | Maximum Wattage | Heats |
|---|---|---|---|---|---|
| "Amer. Beauty" | Amer. Elec. Heater Co., Detroit, Mich.................... | Chafing Dish | 3 pt. | 420 | 2 |
| "Amer. Beauty" | | Chafing Dish (Plain) | 3 pt. | 420 | 2 |
| "Amer. Beauty" | " " " | Percolator (Urn) | 6 cups | 420 | .. |
| "Amer. Beauty" | " " " | Percolator (Urn) | 7 cups | 420 | .. |
| "Amer. Beauty" | " " " | Percolator (Urn) | 9 cups | 420 | ..1 |
| "Amer. Beauty" | " " " | Disc Stove | 4 in. | 450 | |
| "Amer. Beauty" | " " " | Disc Stove | 5 in. | 500 | 1 |
| "Amer. Beauty" | " " " | Disc Stove | 6 in. | 600 | 1 |
| "Amer. Beauty" | " " " | Toaster (Upright) | ...... | 440 | 1 |
| "Rite Heat" | " " " | Toaster (Stove) | 5x5 in. | 500 | 11 |
| .................... | Armstrong Mfg. Co., Huntington, W. Va............... | Table Stove (Waffle Iron Attach.) | 6¾x6¾ in. | 600 | |
| "Bestov Baby" | Bestov Appliance Co., Seattle, Wash.................... | Toaster (Stove) | 5¼x5 in. | 400 | 1 |
| "Bestov" | | Toaster | 5x9 in. | 400 | 1 |
| "Bestov" | " " | Table Stove | 6x8½ in. | 660 | 1 |
| "Bestov" | " " | Hot Plate | 9x6½ in. | 660 | 3 |
| "Bestov" | " " | Twin Stove | 9x18x6½ in. | 650 | ... |
| "Bestov" | " " | Twin Stove | 10x20x6½ in. | 700 | 1 |
| "Junior" | Geo. Borgfeldt, New York, N. Y.................... | Toaster (Stove) | 2½x7x5 in. | ... | 1 |
| "O-Kay" | Coolee Engineers, Cleveland, O. | Table Stove | 5⅛x6⅛ in. | 320 | 1 |
| "Reddy" | Curtainless Shower Co., New York, N. Y................ | Toaster | 4¾x8 in. | 440 | 1 |
| "Hotpoint" | Edison Elec. Appliance Co., Chicago, Ill................ | Disc Stove (*) | 4½ in. Dia. | 400 | 1 |
| "Hotpoint" | | Disc Stove | 6 in. Dia. | 600 | 1 |
| "Hotpoint" | " " " | Radiant Stove | 7¼ in. Dia. | 550 | 1 |
| "Hotpoint" | " " " | Toaster Stove | 5½x10½x4 | 500 | 1 |
| "Hotpoint" | " " " | Toaster, 2 Slice | 4x6¾x7 | 450 | 1 |
| "Hotpoint" | " " " | Toaster, 2 Slice | 4x9x8 | 550 | 1 |
| "Hotpoint" | " " " | Tea Kettle | 2½ pt. | 400 | 1 |
| "Hotpoint" | " " " | Tea Pot | 7 cups | 400 | 1 |
| "Hotpoint" | " " " | Chafing Dish | 2 qt. | ... | .. |
| "Hotpoint" | " " " | Chafing Dish (Bowl) | 2 qt. | 450 | 2 |
| "Hotpoint" | " " " | Percolator (AP) | 6 cups | 400 | 1 |
| "Hotpoint" | " " " | Percolator (NP) | 5 cups | 400 | 1 |
| "Hotpoint" | " " " | Percolator (NP) | 6 cups | 400 | 1 |
| "Hotpoint" | " " " | Percolator (NP) | 9 cups | 400 | 1 |
| "Hotpoint" | " " " | Percolator (S) | 12 cups | 400 | 1 |
| "Hotpoint" | " " " | Water Pot (S) | 2 pt. | 400 | 1 |
| "Hotpoint" | " " " | Tea Pot (S) | 3 pt. | 400 | 1 |
| "Reverso" | Electro-Weld Co., Lynn, Mass. | Toaster | .............. | 500 | 1 |
| "Empire" | Empire Transformer Co., Chicago, Ill.................. | Toaster | 10x6x3½ in. | 500 | 1 |
| "Star" | Fitzgerald Mfg. Co., Torrington, Conn................ | Toaster (R) | 8½x7 in. | 440 | 1 |
| .................... | Galvo Elec. Co., Cleveland, O. | Toaster | 5x6 | 440 | 1 |
| "Universal" | Landers, Frary & Clark, New Britain, Conn.............. | Percolator | 4 cups | 420 | 1 |
| "Universal" | | Percolator | 5 cups | 420 | 1 |
| "Universal" | " " " | Percolator | 6 cups | 420 | 1 |
| "Universal" | " " " | Percolator | 7 cups | 420 | 1 |
| "Universal" | " " " | Percolator | 9 cups | 420 | 1 |
| "Universal" | " " " | Coffee Urn | 6 cups | 420 | 1 |
| "Universal" | " " " | Coffee Urn | 9 cups | 420 | 1 |
| "Universal" | " " " | Tea Pot | 6 cups | 420 | 1 |
| "Universal" | " " " | Samovar | 6 cups | 420 | 1 |
| "Universal" | " " " | Water Kettle | 2½ pt. | 420 | 1 |
| "Universal" | " " " | Water Kettle | 3 pt. | 420 | 2 |
| "Universal" | " " " | Chafing Dish | .............. | 420 | 2 |
| "Universal" | " " " | Comb. Chafer | .............. | 550 | 2 |
| "Universal" | " " " | Toaster | 6¾ in. | 340 | 1 |
| "Universal" | " " " | Toaster | 10 in. | 340 | 1 |
| "Universal" | " " " | Toaster (R) | 7 in. Dia. | 400 | 1 |
| "Universal" | " " " | Disc Stove | 6 in. Dia. | 550 | 1 |
| "Universal" | " " " | Disc Stove | 6 in. Dia. | 550 | 2 |
| "Universal" | " " " | Waffle Iron | .............. | ... | .. |
| "Teddy" | A. G. Lucas Company........ | Grill | 8¼x4-⅛x2¾in. | 550 | 1 |
| .................... | Manning, Bowman & Co., Meriden, Conn............. | Toaster (U) | .............. | 440 | 1 |
| .................... | | Egg Boiler | .............. | 400 | 1 |
| .................... | " " " | Grill | 8½ in. Dia. | 550 | 3 |
| .................... | " " " | Percolator Urn (NP) | 8 cups | 400 | 1 |
| .................... | " " " | Percolator Urn (SP) | 7 cups | 400 | 1 |
| .................... | " " " | Percolator Pot (AP) | 8 cups | 400 | 1 |
| .................... | " " " | Tea Pot (NP) | 6 cups | 400 | 1 |
| .................... | " " " | Water Kettle | 3 pt. | 400 | 1 |
| .................... | " " " | Percolator Pot (NP) | 6 cups | 400 | 1 |
| "Little Chex" | W. B. McAllister Co., Cleveland, Ohio................ | Table Stove | 7⅝x6 11/16x2⅝ in. | 450 | 1 |
| "White Cross" | National Stamping & Elec. Wks., Chicago, Ill.......... | Toaster (Stove) | 10½x6¾x3 in. | 550 | 1 |
| "White Cross" | | Table Stove | 12x6¾x3 in. | 550 | 1 |
| "White Cross" | " " " | Comb. Stove | 12x6¾x8 in. | 550 | 1 |
| .................... | National Transformer Mfg. Co., Chicago, Ill............... | Toaster (Stove) | 5x9x3 in. | 450 | 1 |
| "Pelouze" | Pelouze Mfg. Co., Chicago, Ill. | Chafing Dish | 3 pt. | 475 | 1 |
| "Pelouze" | " " " | Egg Boiler | 1½ pt. | 250 | 1 |
| "Pelouze" | " " " | Disc Stove | 4½ in. Dia. | 250 | 1 |
| "Pelouze" | " " " | Disc Stove | 6 in. Dia. | 475 | 1 |
| "Pelouze" | " " " | Toaster (U) | .............. | 450 | 1 |
| "Pelouze" | " " " | Toaster Stove | 6½x12 in. | 300 | 1 |
| "Redtop" | Redtop Elec. Co., Inc., New | Toaster (Stove) | 6x6 in. | 500 | 1 |

## TABLE UTENSILS (Continued)

| Trade Name | Name and Address of Manufacturer | Utensil or Type | Size or Capacity Dimension | Maximum Wattage | Heats |
|---|---|---|---|---|---|
| "Redtop" | York, N. Y. | Toaster (Stove) | 6x6 in. | 600 | 1 |
| "Redtop" | " " " | Toaster (Stove) | 6x8 in. | 600 | 1 |
| "Redtop" | " " " | Toaster (Stove) (D) | 6x8 in. | 500 | 1 |
| "Redtop" | " " " | Kitchenette (D) | 7x14 in. | 660 | 2 |
| "Redtop" | " " " | Stove (D) | 7x14 in. | 660 | 2 |
| "Redtop" | " " " | Grill (D) | 7x14 in. | 660 | 2 |
| "Royal Rochester" | Rochester Stamping Co., Ro- | Chafing Dish | 3 pt. | 600 | 1 |
| "Royal Rochester" | chester, N. Y. | Chafing Dish | 3 pt. | 600 | 3 |
| "Royal Rochester" | " " " | Percolator | 7 cups | 450 | 1 |
| "Royal Rochester" | " " " | Percolator (C) | 5 cups | 450 | 1 |
| "Royal Rochester" | " " " | Disc Stove | 4½ in. | 600 | 1 |
| "Royal Rochester" | " " " | Toaster | 6¾x6¾x4 | 500 | 1 |
| "Royal Rochester" | " " " | Toaster | 7⅝x8¾x4 | 550 | 1 |
| "Hold-Heet" | Russell Elec. Co., Chicago, Ill. | Toaster (Stove) | 6x6 in. | 400 | 1 |
| "Hold-Heet" | " " " | Toaster (A) | .............. | 500 | 1 |
| "Hold-Heet" | " " " | Grill (Stove) | 5x9 in. | 500 | 1 |
| "Hold-Heet" | " " " | Hot Plate (SB) | 10x11x4½ | 1100 | 3 |
| "Hold-Heet" | " " " | Hot Plate (DB) | 20½x11x4½ | 2200 | 3 |
| "Flip-Flop" | Rutenber Elec. Co., Marion, | Toaster, 2 Slice | 5½ in. | 500 | 1 |
| .................... | Ind. | Table Stove | 7x7 in. | 600 | 1 |
| "Challenge" | Security Elec. Mfg. Co., Chi- | Toaster | 6x5½ | 450 | 1 |
| "World's Best" | cago, Ill. | Toaster (Stove) | 10x6 in. | 500 | 1 |
| .................... | Simplex Elec. Heating Co., | | | | |
| | Cambridge, Mass. | Toaster | .............. | 475 | 1 |
| "Tamco" | Triangle Appliance Mfg. Co., | | | | |
| | Chicago, Ill. | Toaster | 9x5 in. | 440 | 1 |
| "Dandy" | Waage Elec. Co., Chicago, Ill. | Toaster (Stove) | 5 in. Dia. | 450 | 1 |
| .................... | | Disc Stove | 5 in. Dia. | 500 | 4 |
| .................... | " " " | Percolator | 9 cups | 440 | 1 |
| .................... | Westinghouse Elec. & Mfg. Co., | Disc Stove | 6 in. Dia. | 600 | 3 |
| .................... | E. Pittsburgh, Pa. | Disc Stove | 6 in. Dia. | 600 | 1 |
| .................... | " " " | Toaster (Stove) | 9x5¼x3⅝ | 550 | 1 |
| "Turn Over" | " " " | Toaster | .............. | 550 | 1 |
| .................... | " " " | Percolator (P) | 9 cups | 402 | 1 |
| .................... | " " " | Percolator (PT) | 7 cups | 420 | 1 |
| .................... | " " " | Percolator (PU) | 8 cups | 420 | 1 |
| .................... | " " " | Percolator (LC) | 9 cups | 420 | 1 |
| .................... | " " " | Chafing Dish | 3 pts. | 600 | 1 |
| .................... | " " " | Chafing Dish | 3 pts. | 600 | 3 |
| .................... | Edwin L. Wiegand Co., Pitts- | | | | |
| | burgh, Pa. | Disc Stove | 4½ in. Dia. | 440 | .. |

ABBREVIATIONS—(*) For 3 Heat Disc Stoves and Single Heat Disc Stoves of a greater diameter than 6 inches (A)—Automatic. (AP)—Aluminum Pot. (C)—China. (D)—Duplex. (DB)—Double Burner. (LC)—Lovlve Cup. (NP)—Nickel Pot. (P)—Palin. (PT)—Panel Type. (PU)—Panel Urn. (R)—Reversible. (S)—Si.rgn (SB)—Single Burner. (SP)—Silver Pot. (U)—Upright.

## VACUUM CLEANERS

| Trade Name | Name and Address of Manufacturer | Style | Weight (Lbs.) | Style and Length of Nozzle (Inches) | Motor H. P. | Motor Switch Control | Motor Maker | Attachments |
|---|---|---|---|---|---|---|---|---|
| "Airway" | Airway Elec. App. Co., Toledo, O. | Cylinder | 9 | 9-Open Nozzle(B) | W | (S) | own | 5 |
| "Arco Wand" | Amer.RadiatorCo. New York, N.Y. | Stationary | 385 | ............ | ½ | ........ | ........ | ........ |
| .............. | Apex Elec. Distrib. Co., Cleve., Ohio. | Sweeper | 10 | 13-(B) | ⅛ | (S) | .............. | 6 |
| "Atwood" | Atwood-Stewart, Vac. Mach. Co., Chicago, Ill. | Stationary Portable Trucks | 400 & up | 12-(O) | ½ & up | ........ | Gen. Elec. | ...... |
| "Bee-Vac" | Birtman Elec. Co., Chicago, Ill. | Sweeper | 10 | 13-(B) | ⅙ | (S) | Own | 5 |
| "Bissell" | Bissell Motor Co., Toledo, Ohio | Cylinder | 25 | 9-Open Nozzle | ¼ | (SF) | F. B. Co. | ...... |
| "Cadillac" | Clements Mfg. Co., Chicago, Ill. | Sweeper | 9 | 12-(B) | ⅙ | (S) | Own | 7 |
| "Cadillac 90" | " " | Sweeper | 9 | 12 | ⅙ | (S) | Own | 7 |
| "Reliable" | " " | Sweeper | 8 | 10½-(B) | ⅙ | (S) | Own | 7 |
| "Little Ben" | " " | Sweeper | 9 | 12-(B) | ⅙ | (S) | Own | 7 |
| "Big Ben" | " " | Sweeper | 12 | 13½-(B) | ¼ | (S) | Own | 7 |
| "Eclipse" | Eclipse Mch. Co., Sidney, Ohio | Sweeper | 10 | 12-(B) | ........ | (S) | Gen. Elec. | 8 |
| "Hotpoint" | Edison Elec. App. Co., Chicago, Ill. | Straight Suction | 18 | 13½ | ........ | (S) | .............. | 7 |
| "Premier" | Elec. Vac. Cleaner Co., Cleve., O. | Sweeper | 11 | 13½-(B) | ⅛ | (S) | Own | 8 |
| Premier Handy | | Handy | 6½ | ............ | ⅛ | (S) | Own | 4 |
| "Eureka" | Eureka Va. Cleaner Co., Detroit, Mich | Air | 10 | 11½-(B) | ⅙ | (S) | Own | 4 |
| .............. | Federal Elec. Co., Chicago, Ill. | Sweeper | 10 | 12-(B) | ⅛ | (S) | .............. | 4 |

## VACUUM CLEANERS (Continued)

| Trade Name | Name and Address of Manufacturer | Style | Weight (Lbs.) | Style and Length of Nozzle (Inches) | Motor H. P. | Motor Switch Control | Motor Maker | Attachments |
|---|---|---|---|---|---|---|---|---|
| "Royal" | P. A. Geier Co., Cleveland, Ohio. | Sweeper | 10 | 14-(B) | ........ | (S) | Domes Elec. | 8 |
| "Thurman" | Gen'l Compressed Air & Vac. Mch. Co.,St.Louis,Mo. | Stationary | 75 up | 9 to 12 | ¼ to 1½ | ........ | Gen. Elec. | ...... |
| | | Truck | 75 up | 9 to 12 | 1/6 to 1½ | ........ | Wagner Elec. | ...... |
| "Hamilton Beach" | Hamilton Beach Mfg. Co., Racine, Wis. | Suction | 14 | 12 | 1/8 | ........ | Own | ...... |
| " " | " " | Sweeper (M) | 15¼ | 12-(B) | 1/5 | (S) | Own | ...... |
| "Baby" | The Hoover Suction Sweeper Co., No. Canton, Ohio | Sweeper (M) | 16 | 12-(B) | ........ | (SN) | Own | 11 |
| "Special" | | Sweeper (M) | 16¾ | 12-(B) | ........ | (SN) | Own | 11 |
| "Junior" | | Sweeper (M) | 41½ | 12-(B) | ........ | (SN) | Robb & Myers | 11 |
| "Senior" | " " | Sweeper (M) | 46½ | 15-(B) | ........ | (SN) | Robb. & Myers | 11 |
| "Airplane" | Hugro Mfg. Co., Warsaw, Ind. | Sweeper (M) | 17½ | 13½-(B) | 1/8 | (SN) | Robb. & Myers | 6 |
| .............. | Invincible Vac. Cleaner Co., Dover, Ohio | Portable | 55 | 10-Open Nozzle | ¼ | (SN) | Westinghouse | ...... |
| .............. | | Truck Type | 55 | 12-Open Nozzle | 3/8 | ........ | West. Univ. | ...... |
| "Jewel" | Jewel Elec. & Mfg. Co., Chicago, Ill. | Sweeper | 9 | 10½-(B) | ........ | (S) | Own | 7 |
| "Quaker" | " " | Sweeper | 9 | 12-(B) | ........ | (SN) | Own | 7 |
| "Junior" | The Kent Co., Inc., Rome, N. Y. | Cylinder | 32 | 10-Open Nozzle | ¼ | ........ | Westinghouse | 13 |
| "Standard" | " " | Cylinder | 48 | 10-Open Nozzle | 1/3 | ........ | Westinghouse | 15 |
| "Jumbo" | " " | Cylinder | 60 | 14-Open Nozzle | 3/8 | ........ | Westinghouse | 14 |
| "Kent" | " " | Stationary | 175 | 10-(B) | 1/8 | ........ | Century El. Co. | 6 |
| "Victory" | Geo. S. Knox Co., Wilkinsburg, Penna. | Stationary & Sweeper | 200 to 500 | 3-12-15 | ¼ to 5 | With or Without | Any | 5 |
| "Universal" | Landers, Frary & Clark, Connersville, New Britain, Conn. | Sweeper | 10½ | 12-(B) | ........ | (S) | .............. | 6 |
| | | Truck Type | 250 | 12 | ¼ | ........ | .............. | 6 |
| .............. | | Staionary(*) | 300 | 12 | ½ | ........ | .............. | 6 |
| .............. | Ira Lee Suction Cleaner Corp., Detroit, Mich. | Sweeper | 14 | 126 | 1/8 | ........ | Own | 8 |
| "Morrow" | The Morrow Co., Waukegan, Ill. | Sweeper | 8¾ | 12-(B) | ........ | (SG) | Gen. Elec. Co. | 5 |
| .............. | Pittsburgh Elec. Spec. Co., New York, N. Y. | Sweeper | 9½ | 12-(B) | 1/6 | (S) | Arrow Elec. Co. | 6 |
| "Gainaday" | Pittsburgh Gage & Supply Co., Pittsburgh, Pa. | Suction | 11 | 13 | ........ | (S) | .............. | 8 |
| "Rayvac" | Ramey Company, Columbus, Ohio | Sweeper | 10 | 12-(B) | 1/8 | (S) | .............. | ...... |
| "New Regina" | Regina Company, New York, N. Y. | Suction | 12 | 12-(SB) | 1/12 | (S) | Own | 8 |
| .............. | B. F. Sturtevant Co. | Cylinder | 41 | 8-Open Nozzle | 1/6 | (SC) | Own | 6 |
| .............. | Hyde Park, Boston. | Stationary | 500 | 12-Open Nozzle | ½ | ........ | Own | ...... |
| "Torrington" | Torrington Co., Nat'l Sweeper Divis., Torrington, Conn | Sweeper | 12 | 13-(B) | 1/8 | (S) | Gen. Elec. Co. | 9 |
| "Ohio-Tuec" | The United Elec. Co., Canton, O. | Air | 11⅛ | 12-(B) | 1/6 | (SN) | .............. | ...... |
| Western Elec. | Western Elec. Co., New York, N. Y. | Sweeper (M) | 14¾ | 11-(B) | 1/8 | (S) | Domes Elec. Co | 6 |
| "America" | Wise-McClung Mfg. Co., New Phila., Ohio | Sweeper | 11½ | 13 | 1/6 | (SN) | Arrow El. Co. | 7 |
| "Sweeper Vac" | M. S. Wright Co., Worcester, Mass. | Sweeper (M) | 14½ | 12-(B) | 1/6 | (S) | Domes El. Co. | 7 |

ABBREVIATIONS—(B)—Brush with or in nozzle. (M)—Motor Driven Brush. (O)—Open Nozzle (S)—Switch on Handle. (SB)—Stationary Brush, Rear of Nozzle. (SC)—Switch on Cord. (SF)—Switch on Frame. (SG)—Switch in Grip. (SN)—Switch on Motor.
(*)—Figures given are for smallest machine; large machines (same type) also made by this company

# Electric Supplies—Wholesalers

### Alabama

Interstate Electric Company, Birmingham.
Matthews Electric Supply Co., Inc., Birmingham.
Moore-Handley Hardware Co., Birmingham.

### California

Alexander & Lavenson Electric Supply Co., San Francisco.
Dunham, Carrigan & Hayden Company, San Francisco.
Electric Appliance Company, San Francisco.
Electric Railway & Manufacturers' Supply Co., San Francisco.
Gilson Electric Supply Company, Oakland.
Graham-Reynolds Electric Company, Los Angeles.
Holabird Electrical Company, San Francisco.
Holabird Electrical Company, Oakland.
Illinois Electric Co., Los Angeles.
Listenwalter & Gough, Inc., Los Angeles.
Pacific States Electric Co., Los Angeles.
Pacific States Electric Co., Oakland.
Pacific States Electric Co., San Francisco.
Western Electric Company, Inc., Los Angeles.
Western Electric Company, Inc., San Francisco.

### Colorado

Hendrie & Bolthoff Mfg. & Supply Co., Denver.
Mine & Smelter Supply Co., Denver.
Mountain Electric Company, The, Denver.
Western Electric Company, Inc., Denver.

### Connecticut

Electric Supply & Equipment Co., Hartford.
Hessell & Hoppen Company, New Haven.
Mersick & Company, C. S., New Haven.
New England Engineering Co., Waterbury.

### District of Columbia

Doubleday-Hill Electric Co., Washington.
National Electrical Supply Co., Washington.

### Florida

Florida Electric Supply Company, Jacksonville.
Florida Electric Supply Company, Tampa.

### Georgia

Carter Electric Company, Atlanta.
Carter Electric Company, Savannah.
Western Electric Company, Inc., Atlanta.

### Illinois

American Electrical Supply Company, Chicago.
Commonwealth Edison Company, Chicago.
Dearborn Division, A. E. S. Co., Chicago.
Electric Appliance Company, Chicago.
Illinois Electric Company, Chicago.
Inland Electric Co., Chicago.
Monarch Electric & Wire Co., Chicago.
North Shore Electric Company, Chicago.
Western Electric Company, Inc., Chicago.

### Indiana

Indianapolis Electric Supply Company, Indianapolis.
National Mill Supply Company, Fort Wayne.
South Bend Electric Co., South Bend.
Varney Electrical Supply Co., Evansville.
Varney Electrical Supply Co., Indianapolis.
Western Electric Company, Inc., Indianapolis.

### Iowa

Andrae, Julius and Sons Company, Mason City.
Downing Electrical Company, Des Moines.
Iowa Electrical Supply Co., Des Moines.
McGraw Company, The, Sioux City.
Mid-West Electric Company, Des Moines.
Republic Electric Company, Davenport.
Terry Company, J. B., Cedar Rapids.

### Kansas

United Electric Company, Wichita.

### Kentucky

Clark Jr. Electric Co., J., Louisville.
Peaslee-Gaulbert Company, Louisville.
Tafel Electric Company, H. C., Louisville.

### Louisiana

Electric Appliance Company, New Orleans.
Electric Supply Company, New Orleans.
Gulf States Electric Co., Inc., New Orleans.
Interstate Electric Company, New Orleans.
Interstate Electric Company, Shreveport.
Western Electric Company, Inc., New Orleans.

### Maryland

Southern Electric Company, Baltimore.

### Massachusetts

Buckminister Company, G. H., Boston.
Hardy & Company, F. S., Boston.
Pettingell-Andrews Company, Boston.
Pettingell Electric Supply Co., R. V., Boston.
Stuart-Howland Company, Boston.
Wahn Company, G. H., Boston.
Western Electric Company, Inc., Boston.
Wetmore-Savage Company, Boston.

### Michigan

Electrical Warehouse, Inc., Detroit.
Hartwig Company, W. J., Detroit.
Knowlson Company, A. T., Detroit.
Litscher Electric Company, C. J., Grand Rapids.
Miller-Seldon Electric Company, Detroit.
McNaughton-McKay Electric Co., Detroit.
Teal Company, F. C., Detroit.
Walker Company, H. L., Detroit.

## ELECTRIC SUPPLIES—WHOLESALERS (Continued)

### Minnesota

Andrae, Julius & Sons Co., Duluth.
Duluth Electrical Supplies Co., Duluth.
Laird Electric Company, R. M., Minneapolis.
Northwestern Electric Equipment Co., Duluth.
Northwestern Electric Equipment Co., St. Paul.
Peerless Electrical Company, Minneapolis.
Sterling Electric Co., Minneapolis.
St. Paul Electric Company, St. Paul.
Western Electric Company, Inc., Minneapolis.

### Missouri

B-R Electric Company, Kansas City.
Central Telephone & Electric Co., St. Louis.
Columbian Electrical Company, St. Joseph.
Commercial Electrical Supply Co., St. Louis.
Funsten Electric Company, Kansas City.
Wesco Supply Company, St. Louis.
Western Electric Company, Inc., Kansas City.
Western Electric Company, Inc., St. Louis.

### Montana

Butte Electric Supply Company, Butte.
Montana Electric Company, Butte.
Montana Electric Company, Great Falls.

### Nebraska

Korsmeyer Company, Lincoln.
McGraw Company, Omaha.
Mid-West Electric Company, Omaha.
Western Electric Company, Inc., Omaha.

### New Jersey

Newark Electrical Supply Company, Newark.
Tri-City Electric Company, Newark.

### New York

Alpha Electric Company, Inc., New York.
Brooklyn Electrical Supply Company, Brooklyn.
Central Electrical Supply Company, New York.
Crannell, Nugent & Kranzer, Inc., New York.
Electric Supply & Equipment Co., Inc., Albany.
Esco Electric Supply Company, Albany.
Fullerton, Inc., F. W. L., New York.
Gorke, Inc., H. J., Syracuse.
Havens Electric Company, Inc., Albany.
Latham & Company, E. B., New York.
Leahy Electric Supplies, Inc., J. J., New York.
Leveridge, Inc., C. W., New York.
McCarthy Brothers & Ford, Buffalo.
Manhattan Electrical Supply Co., Inc., New York.
Mohawk Electrical Supply Company, Syracuse.
Northwestern Electric Equipment Co., New York.
Roberts Electric Supply Co., H. C., Syracuse.
Robertson-Cataract Electric Company, Buffalo.
Rochester Electrical Supply Company, Rochester.
Royal-Eastern Electrical Supply Co., New York.
Sackett Electric Company, H. I., Buffalo.
Sibley-Pitman Electric Corp., New York.
Stanley & Patterson, Inc., New York.
Syracuse Supply Company, Syracuse.
Troy Electrical Company, Troy.
Utica Electrical Appliance Co., Utica.
Western Electric Company, Inc., Buffalo.
Western Electric Company, Inc., New York.
Wheeler-Green Electrical Supply Co., Rochester.

### Ohio

Avery & Loeb Electric Company, Columbus.
Bissell Company, F., Toledo.
Creaghead Engineering Company, Cincinnati.
Erner Electric Company, Cleveland.
Erner & Hopkins Company, Columbus.
Hall Electric Company, W., Dayton.
Hardware & Supply Company, Akron.
Luetkemeyer Company, Cleveland.
Milnor Electric Company, Cincinnati.
Moock Electric Supply Company, Canton.
Moock Electric Supply Company, Youngstown.
Post-Glover Electric Company, Cincinnati.
Republic Electric Company, Cleveland.
Western Electric Company, Inc., Cincinnati.
Western Electric Company, Inc., Cleveland.

### Oregon

Fobes Supply Company, Portland.
North Coast Electric Company, Portland.
Pacific States Electric Company, Portland.
Stubbs Electric Company, Portland.

### Oklahoma

United Electric Company, Oklahoma City.

### Pennsylvania

Buchanan Supply Company, J. F., Philadelphia.
Doubleday-Hill Electric Company, Pittsburgh.
Electric Supply & Equipment Co., Inc., Reading.
Electric Supply & Equipment Co., Inc., Scranton.
Elliott-Lewis Electrical Co., Inc., Philadelphia.
Franklin Electric Company, Philadelphia.
Iron City Electric Company, Pittsburgh.
Jones-Beach & Company, Philadelphia.

## ELECTRIC SUPPLIES—WHOLESALERS (Continued)

### Pennsylvania (Continued)

McCullough Electric Company, W. T., Pittsburgh.
Novelty Electric Company, Philadelphia.
Parke Company, J. Y., Philadelphia.
Philadelphia Electric Company, Philadelphia.
Robbins Electric Company, Pittsburgh.
Roberts Electric Supply Co., H. C., Philadelphia.
Rumsey Electric Company, Philadelphia.
Scott Company, C. B., Scranton.
Star Electric Company, Erie.
Stewart Electric Company, F. H., Philadelphia.
Union Electric Company, Pittsburgh.
Western Electric Company, Inc., Philadelphia.
Western Electric Company, Inc., Pittsburgh.
Woodring & Company, J., Hazleton.

### Rhode Island

Belcher & Loomis Hardware Company, Providence.
Union Electric Supply Co., Providence.

### South Carolina

Perry-Mann Electric Company, Columbia.

### Tennessee

Electric Supply Company, Memphis.
James Supply Company, Chattanooga.

### Texas

Electric Appliance Company, Dallas.
Mine & Smelter Supply Company, El Paso.
Southwest General Electric Co., Dallas.
Southwest General Electric Co., El Paso.
Southwest General Electric Co., Houston.
Tel-Electric Company, Houston.
Western Electric Company, Inc., Dallas.

### Utah

Capital Electric Company, Salt Lake City.
Inter-Mountain Electric Company, Salt Lake City.
Mine & Smelter Supply Company, Salt Lake City.
Western Electric Company, Inc., Salt Lake City.

### Virginia

Southern Electric Company, Richmond.
Tower-Binford Electric & Mfg. Co., Richmond.
Western Electric Company, Inc., Richmond.
Woodhouse Electric Company, Inc., Norfolk.

### Washington

Fobes Supply Company, Seattle.
North Coast Electric Company, Seattle.
North Coast Electric Company, Tacoma.
Pacific States Electric Company, Seattle.
Washington Electric Supply Company, Spokane.
Western Electric Company, Inc., Seattle.

### West Virginia

Fairmont Mining Machinery Company, Fairmont.
Sands Electric & Mfg. Co., H. S., Wheeling.
Superior Supply Company, Bluefield.

### Wisconsin

Andrae & Sons Company, J., Milwaukee.
G-Q Electric Company, Milwaukee.
Roosevelt Company, W. A., La Crosse.

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